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BOTANICAL PHENOMENA AND THE PROBLEM OF RECENT COASTAL SUBSIDENCE[1]

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(WITH NINE FIGURES)

Fifty-five years ago GEORGE H. COOK[2] published his important paper on the subsidence of the land along the coasts of New Jersey and Long Island, in which he cited much evidence to prove that these coasts were gradually sinking at a rate of more than half a meter per century. Before this time a number of writers had called attention to certain phenomena which seemed to them to indicate a progressive subsidence of the coast; and since the publication of COOK's article, many reports upon this interesting subject have appeared. A few of these authors have argued in favor of the recent elevation of certain parts of the coast; a few others have maintained that the evidence of recent changes of level were not convincing; but by far the greater number have supported the theory of recent subsidence, and have described indications of a sinking of the land for almost all parts of the coast between Prince Edward Island and Florida. It is today generally accepted as a well established fact that the Atlantic coast of North America is gradually subsiding, at a rate which is variously estimated from 20 to 75 cm. per century.

[1] The substance of a portion of this paper formed part of an article published in the Annales de Géographie, May 1912, under the title "Fixité de la côte Atlantique de l'Amérique du Nord."

[2] COOK, G. H., On a subsidence of the land on the seacoast of New Jersey and Long Island. Amer. Jour. Sci. II. **24**:341–354. 1857.

The supposed changes of level of the Atlantic coast have interested me for several years. A study of the form of Nantasket Beach, near Boston, showed that this portion of the coast could not have subsided more than a meter during the last 1000 or 2000 years.[3] An examination of certain shore line changes produced at Scituate, also near Boston, by the great storm of 1898, showed that all the appearances of a subsidence of the coast could be produced by an increased height of high tide resulting from a change in the form of the shore line.[4] Finally, aided by a grant from the Shaler Memorial Fund of Harvard University, by the excellent services of my three assistants, Messrs. D. C. BARTON, J. K. WRIGHT, and G. B. REED, and by the cordial cooperation of a large number of geologists, engineers, and officials of state and national surveys, I have been able to study the most important localities on the Atlantic coast from the northern side of Prince Edward Island to the Florida Keys, as well as a number of places on the coasts of Sweden, England, and Holland. The results of these studies seem to me to justify, for the Atlantic coast of North America, the following conclusions: (1) There can have been no long-continued progressive subsidence of this coast at a rate of 20 cm. or more per century, during the last few thousand years. The coast has remained at least comparatively stable throughout this period. (2) The coast cannot have subsided as much as 30 cm. in the last century. (3) There is no satisfactory evidence of any subsidence whatever during the last few thousand years.

In the present paper no attempt is made to consider all phases of the interesting problem of recent coastal subsidence; attention is here directed exclusively to the consideration of some of the botanical phenomena supposed to prove such a subsidence. If apology is needed for my venturing to discuss botanical phases of the question, and in a botanical journal, my plea is that I am a firm believer in what has been aptly termed cross-fertilization of the sciences. The study of a complex problem has forced me to

[3] JOHNSON, D. W., and REED, W. G., The form of Nantasket Beach. Jour. Geol. **18**:162–189. 1910.

[4] JOHNSON, D. W., The supposed recent subsidence of the Massachusetts and New Jersey coasts. Science N.S. **32**:721–723. 1910; also The botanical evidence of coastal subsidence. Science N.S. **33**:300–302. 1911.

investigate botanical phases of the question, and my modest excursions into the realms of a sister science have been made most profitable because of the courtesy and generous assistance of some of my botanical colleagues. I shall be glad if the observations here set down prove of interest to some of the many students of botany who have noted the indications of changes of level afforded by plant life along the coast.

Throughout this article the expression "recent subsidence" is employed to designate subsidence within the last few thousand years, and "remote subsidence" to designate a sinking of the land which occurred more than 4000 or 5000 years ago. One may divide the botanical evidences of recent subsidence of our Atlantic coast into three classes, according as they are (1) wholly fictitious appearance of changes of level; (2) phenomena produced by local changes in tidal heights without any real change in the general level of either land or sea; and (3) phenomena really produced by a sinking of the land, but produced so long ago that they cannot properly be cited as proofs of a subsidence within the last few thousand years. Let us first consider those supposed proofs of recent subsidence which are based on

1. Fictitious appearance of changes of level

STANDING FORESTS KILLED BY THE INVASION OF THE SEA

At many points on the Atlantic coast one may observe large numbers of trees killed by salt water so recently that they still stand erect, and even retain their branches. These trees have often been cited as a convincing proof of the recent progressive subsidence of the land. Among the localities where standing forests killed by the sea have been supposed to show with special clearness a recent subsidence of the land, I will mention but a few. GANONG[5] in one of his series of "Notes on the natural history and physiography of New Brunswick," speaking of the low shores of South River, near Pokemouche, says, "in places the dead forest trees still standing with their roots immersed by the highest tides,

[5] GANONG, W. F., On the physiographic characteristics of the Pokemouche and St. Simon rivers. Bull. Nat. Hist. Soc. New Brunswick **5**:524–526. 1906.

afford striking evidence of the rapid subsidence this coast is undergoing." ABRAHAM GESNER[6] described standing forests of beech, birch, and maple, killed by the seawater which overflowed their roots, as a proof that the coasts of Cascumpeque Harbor in Prince Edward Island had undergone the most recent subsidence of which he had knowledge. COOK, in the paper referred to in the first paragraph of this article, describes dead forests still standing, found on several parts of the New Jersey coast. Sir CHARLES LYELL[7] saw in standing forest trees killed by the tide near the mouth of Cooper River, South Carolina, a proof of very modern subsidence of that coast.

The region described by GANONG has been examined by GOLDTHWAIT, with whom I have had the privilege of cooperating in the work along the coast of southeastern Canada. After a careful study of the dead trees on this part of the coast, GOLDTHWAIT[8] has reached the conclusion that death has resulted in some cases from fire, and in others from a local rise in the high tide level after the manner indicated in section 2 below. I have myself made a careful study of the Cascumpeque Harbor locality and find that the dead trees described by GESNER may be reasonably explained without imagining a subsidence of the coast.[9] Three distinct causes have operated to kill the forest of this portion of the shore. On the outer side of the barrier beach the waves are cutting away the shore and hurling the sands up into the forest. During storms the waves break over the sandy accumulation, and the salt water saturates the sand about the roots of the trees and is ponded back in the low depressions, remaining long enough to kill the trees. Forests killed in a similar manner are found on parts of the North Carolina capes. Inside Cascumpeque Harbor the small waves of the bay have gently sapped the mainland shores, removing the

[6] GESNER, ABRAHAM, On elevations and depressions of the earth in North America. Quar. Jour. Geol. Soc. London **17**:381–388. 1861.

[7] LYELL, CHARLES, Travels in North America. London. 1845. **1**:174–175.

[8] GOLDTHWAIT, J. W., Supposed evidences of subsidence of the coast of New Brunswick within modern times. Unpublished manuscript to appear in an early issue of the Victoria Museum Bulletin.

[9] JOHNSON, D. W., The shore line of Cascumpeque Harbor, Prince Edward Island. Geog. Jour. London **42**:152–164. 1913.

earth from about the roots of the trees along the low coast and thus exposing them to salt water. The barrier beach which separates the bay from the ocean is interrupted by several tidal inlets; and a variation in the number and width of these inlets has permitted a local rise in the high tide surface with a consequent invasion of the forest by the salt water (see section 2 below). The dead forests along the coasts of New Jersey, the Carolinas, and Georgia, many of which I have examined, are most frequently to be explained

FIG. 1.—Live trees in Albemarle Sound, giving fictitious appearance of coastal subsidence.

as the result of such local fluctuations of high tide level. I have seen no case where the killing of the trees could safely be ascribed to a sinking of the coast. On the contrary, the localization of the dead trees at those points on the coast most favorable to the operation of the local causes mentioned above, and certain others described later, is sufficient evidence that their death is not the result of a general subsidence of the land.

As a variant of the above type of evidence, one may class the occurrence of live trees standing in deep water at the heads of

sounds and bays, where the water is too fresh to readily kill trees which have reached maturity. It is evident that these trees could not have commenced to grow in water 5 or 10 feet deep, and it was therefore with especial interest that I learned from Dr. C. A. DAVIS that great numbers of such trees occurred near the headward portion of Albemarle Sound, especially in the vicinity of Elizabeth City, North Carolina, affording, in his opinion, exceptionally good proof of recent coastal subsidence. On visiting the locality I found hundreds of live cypresses standing in water which was often over 5 feet in depth; but the spreading base of these trees was just above water level at the same elevation as on the adjacent low shore (fig. 1); while the underwater parts divided into spreading roots between which an oar could be readily passed. It was quite evident that the trees had grown, like their neighbors, on a low coast composed of peaty soil; and that the washing away of the soil by waves had left the trees standing out in the water. This interpretation was confirmed by the finding of occasional islets of peat about some of the isolated trees. There was no indication of any change in the relative level of land and sea.

SUBMERGED STUMPS

Closely allied to the foregoing botanical evidence of subsidence is that furnished by submerged stumps. These are found along all parts of the Atlantic coast, at depths varying from a few inches below high tide to ten feet or more below low tide level, and have been repeatedly cited by both botanists and geologists as conclusive proofs of recent subsidence. It is hardly necessary to cite specific descriptions of these submerged stumps, as they are such common features along our shores.

A study of the submerged stumps convinces one that there is a great variety of ways in which they may be produced independently of coastal subsidence. Along the low shores of South Carolina and Georgia the small waves formed in the passage between the "Sea Islands" continually undermine trees and let them down into the salt water. So gently does the process operate that the trees often remain erect; and I have seen all stages from trees still living on the edge of the shore 0.5–1 meter above tide,

through others whose broad spreading roots were half undermined, thus allowing the trees to incline forward and sink toward the lower level, to still others which had been wholly undermined and had tipped back to a nearly vertical position, standing erect but dead in the salt water. These trees later break off at the water line and give upright submerged stumps. The fact that dead trees and submerged stumps are often produced in this manner was clearly recognized by TUOMEY[10] in his interesting report on the geology of South Carolina. This same author[11] likewise emphasized the fact that many so-called submerged stumps are merely tap roots of certain trees which descend to a great depth. The loblolly pine has a tap root as large as its trunk which runs down 2 or 3 meters, and then sends off smaller roots. A forest of such trees growing on a low coast may be attacked by the waves, and as the earth is removed the trees die and finally break off at or below water level. In this way deeply submerged "stumps" are produced which will seem to the ordinary observer a convincing proof of subsidence.[12] Fig. 2 is a diagrammatic representation of several stages in this process, which we found particularly well shown in the "Sea Islands" of Georgia.

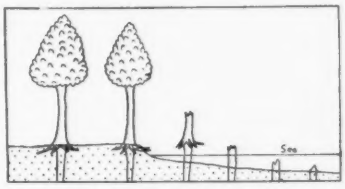

FIG. 2.—Submerged stumps resulting from normal retrogression of the shore line.

Where the sea is cutting into the "Black Bank," a peat bog near Cascumpeque Harbor, many stumps had been washed out of the bog, transported by waves and currents some little distance, and left stranded, often in an upright position, on the beach and in the shallow water of the bay. Submerged stumps, due to a local rise of the high tide level, to the compression of peat bogs caused by a lowering of the ground-water level as the waves cut into the shoreward side of such bogs (fig. 3), to the compression of peat

[10] TUOMEY, M., Report on the geology of South Carolina. Columbia. 1848. p. 194.

[11] *Op. cit.*, 195.

[12] LYELL, CHARLES, A second visit to the U.S. of North America. 2d ed. London. 1850. 1:316–317.

deposits under the weight of barrier beaches (fig. 4), and to other causes, have been observed at many points along the coast. The more one sees of this type of evidence the more does he realize its unreliability.

SUBMERGED PEAT

Another botanical evidence of subsidence, frequently appealed to with confidence by those who believe in recent subsidence of the Atlantic coast, is the submerged peat exposed at many points along the shores, sometimes a little below high tide, often a con-

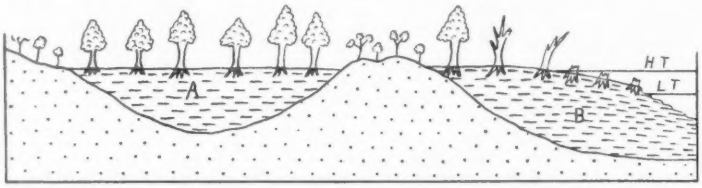

FIG. 3.—Submerged peat and stumps produced by an invasion of peat bogs by the sea; *HT*, high tide; *LT*, low tide.

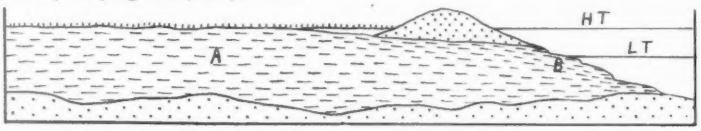

FIG. 4.—Submerged peat outcropping at low tide (*B*) compressed by weight of barrier beach, which is encroaching on salt marsh peat deposit (*A*); *HT*, high tide; *LT*, low tide.

siderable distance below low tide. Such deposits may consist of the remains of fresh water vegetation, or of the remains of marine plants; and both types of deposits have been cited as proofs of a recent sinking of the coast. The fresh peat is frequently overlaid by salt peat; sometimes the reverse is the case; while in other places one or the other type of peat occurs alone. It is uncommon, however, to find such a repeated interstratification of fresh peat with marine deposits as SKERTCHLEY[13] has described for the English fenland, or CAYEUX[14] for a portion of the French coast, although

[13] SKERTCHLEY, S. B. J., The geology of the fenland. Memoir Geol. Surv. England and Wales. London. 1877. pp. 145–151, 172–174.

[14] CAYEUX, L., Les tourbes immergées de la côte Bretonne dans le région de Plougasno-Primel (Finistère). Bull. Soc. Géol. France IV. **6**: 142–147. 1906.

essentially the same conditions developed on a small scale are occasionally encountered on our coast.

Evidently the fresh peat cannot have formed in its present position, exposed to marine action. Indeed, it has been argued that such peat containing upright stumps cannot form in depressions below high tide level back from the shore line because the level of the ground-water would cause such depressions to contain ponds of water in which trees would not grow. Hence it is concluded that submerged fresh peat is a proof of recent coastal subsidence. This conclusion seems to me open to criticism on several grounds. In the first place, "floating bogs" formed of sphagnum and carrying trees of considerable size upon them sometimes cover the surfaces of ponds. The sinking of such a bog, as the trees increase in size or as new material is added to its upper surface, would carry upright stumps down below sea-level. Decomposition of bogs to produce such a semi-liquid mass as is often found under their surfaces might permit stumps to sink slowly to the bottom and remain upright there. The possibility of some such history for a peat bog encroached upon by the sea must be definitely excluded by those who would employ these bogs as a proof of coastal subsidence. In the second place, it should be noted that the lower portions of such bogs may be of very great antiquity; even if they formed above sea-level and were carried downward by subsidence of the coast, this event may have taken place many thousands of years ago. Hence such submerged bogs should not be offered as a proof of recent subsidence (within the last 2000 or 3000 years), as has so often been done. In the third place, when such a bog is encroached upon by the sea, the level of the ground-water table in the bog, formerly at or near its surface, is rapidly lowered. Near the seaward margin of the bog the ground-water table may decline to mean sea-level; and, right at the margin, to low tide level when the tide is out. As a result of this removal of water, the surface of the bog is rapidly lowered, carrying down with it trees which are killed by exposure to high tide (fig. 3). How extensive such a settling of the surface may be, is suggested by fig. 5, which represents the result of an artificial lowering of the ground-water level. Furthermore, the alternate

submergence and draining of the bog removes so much of its content that the surface may even slope down to a level considerably below that of low tide. Submerged deposits of fresh peat containing upright stumps, therefore, are not to be regarded as a conclusive proof of subsidence, either remote or recent.

The salt marshes of a portion of our coast are underlaid by peat, often remarkably pure and reaching a depth of 6 meters or more, composed largely of the roots of *Spartina patens* and other

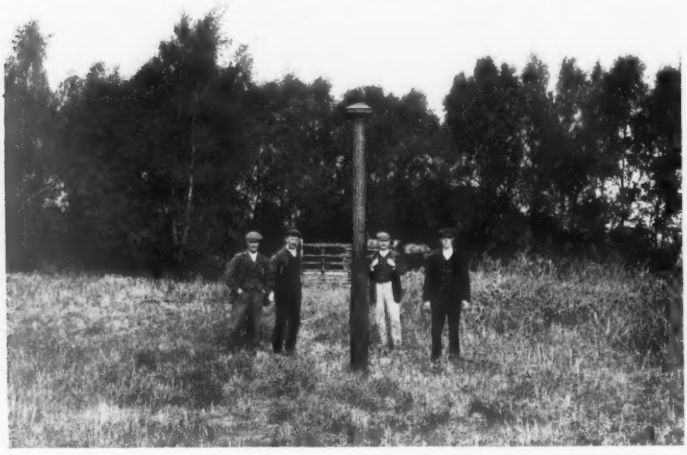

FIG. 5.—Settling of peaty land due to artificial lowering of ground-water level in the fenland of England; in 1848 the surface of the land was even with the top of the post.

salt marsh grasses which grow only near the high tide level. In 1862 MUDGE[15] called attention to this structure of the salt marshes along the New England coast, and showed that the deeply buried portions of the peat must have formed at high tide level. Their present position he attributed to an undermining of the subsoil by fresh water, known by borings to descend from the upland and to pass through the sand found below a clay bed under the marsh

[15] MUDGE, B. F., The salt marsh formations of Lynn. Essex Inst. Proc. 2:117–119. 1862.

near Boston; an explanation which seems hardly competent to account for such a widespread phenomenon. More recently DAVIS[16] of the United States Bureau of Mines, an expert in the examination of peat deposits, has placed especial emphasis upon that feature of salt marshes described by MUDGE, and believes that he has found therein a conclusive proof of a gradual subsidence of the Atlantic coast, probably not faster than a foot a century, continuing up to the present time. Others have likewise thought that they found in submerged salt peat a proof of recent subsidence, and have cited the outcropping of such peat at low tide on the seaward side of barrier beaches, bearing the impressions of the hoofs of cattle and horses and of wagon wheels, as certain proofs of very recent marked subsidence.

It is well known that the attack of the waves often drives a barrier beach inward over the salt marsh. The enormous weight of the beach necessarily results in a compression of the peat deposit, so that the surface of the latter is exposed near or below low tide level on the seaward side of the beach (fig. 4). On the coast near Boston a barrier beach has been driven back over a salt marsh more than 70 meters in twelve years. Today the former surface of the meadow, with the wheel tracks of an old road, impressions of horses hoofs, and the stumps of trees which had gained a foothold on the marsh inside of the beach, are all exposed at low tide on the seaward side of the beach. Those who would interpret this as a result of coastal subsidence must admit a subsidence of perhaps two meters in twelve years, of which there is no corroborating evidence whatever. In fact, the bending down of the former surface of the marsh is readily apparent where the peat outcrops toward the sea; and the fact of extensive compression is shown by two sections taken through the peat deposit; one in the marsh a short distance back of the beach, revealing about four meters of relatively soft peat; the other near low tide level, showing but one meter of very dense, compact, tough peat. The seaward slope of the former marsh surface may be obscured back of the beach by more recent deposits built up to high tide level (fig. 4).

[16] BASTIN, E. S., and DAVIS, C. A., Peat deposits of Maine. Bull. 376, U.S. Geol. Surv. 19–21. 1909; also DAVIS, C. A., Salt marsh formation near Boston, and its geological significance. Economic Geology **5**:625. 1910.

In sections 2 and 3 below we will inquire further into the reliability of salt peat below sea-level as a proof of recent subsidence.

2. Phenomena produced by a local rise in the high tide level

It has seemed necessary to treat the fictitious appearances of changes of level as fully as has been done above, because of the widespread belief in the value of such phenomena as proofs of coastal subsidence. The local fluctuations of high tide level, now

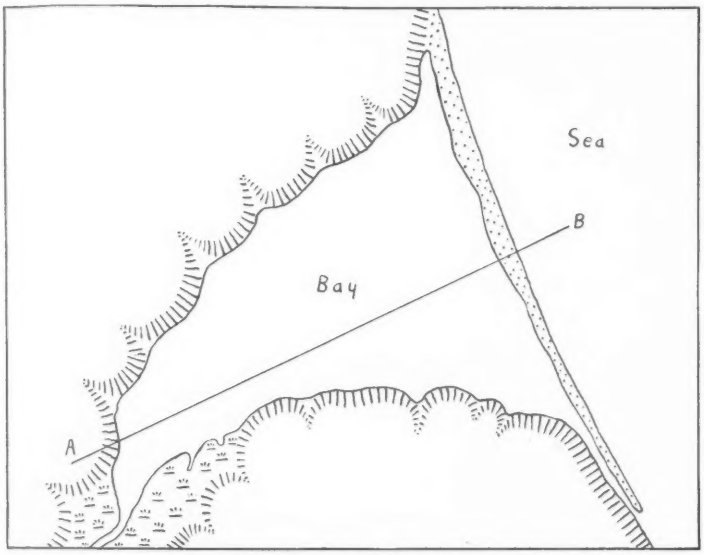

FIG. 6.—Bay separated from the open sea by a barrier beach

to be discussed, are of much greater importance, but may be explained in a shorter space. The principle of these fluctuations will be readily apparent from figs. 6–8.

On a tidal coast, if we have a bay like that shown in fig. 6, almost separated from the open sea by a barrier beach, but connected with it by a narrow tidal inlet, the waters of the rising tide in the sea will pass through the tidal inlet with so much difficulty that the surface of the bay will rise much more slowly than the surface of the sea. When the tide in the sea has reached its

maximum, and has begun to fall, the surface of the bay will still remain much lower. When it is low tide in the sea, the water in the bay will remain at a higher level, because this water cannot escape fast enough to maintain equality of levels between the two water bodies. Hence, high tide level in the bay is lower than high tide level in the sea. This is shown in fig. 7, which represents a cross-section of such a bay as fig. 6 in the direction *AB*. It is evident that around the shores of the bay, trees and other fresh water vegetation will grow down to the level of the high tide of the bay, and thus *below* the high tide level of the adjacent sea. Salt marshes in the bays will likewise grow up to the high tide level of the bay, farmers will build dikes to reclaim their marshes

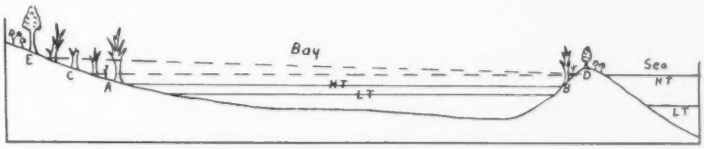

FIG. 7.—Diagram showing fictitious subsidence of the coast; as long as the barrier beach (*D*) nearly closes the mouth of the bay, high tide (*HT*) in the bay is lower than high tide in the open sea; trees grow down to this lower level (*AB*) along the shores of the bay; when the barrier beach is broken through or removed, high tide in the bay rises as high (*CD*) as the open sea, and all the trees between the levels *AB* and *CD* are killed by the salt water; if the bay narrows going inland, the tide is forced to rise even above the level it attains in the open sea, or to the position *ED*, and at the head of the bay all the trees between *A* and *E* are killed; in addition to these submerged forests, other fictitious indications of subsidence are thus produced.

at this same level, and in other ways the level will be so marked as to render readily perceptible any increase in the height of the tides.

Now let us consider the consequences which must follow if storm waves make a large breach in the barrier beach. With free access to the bay through the larger opening, the tidal waters will at once rise as high in the bay as in the open sea (*CD*, fig. 7). All trees whose bases are below the line *CD* will be washed by the tides and killed. The standing forests of dead trees will later be represented by submerged stumps. Dikes raised by the farmers will be overflowed by the tides. The surface of the salt marsh will build up to the new high tide level, enveloping both stumps

and dikes. Fresh water peat, formerly beyond the reach of salt water, may now be buried under a layer of salt peat. In short, most of the phenomena usually cited as proofs of general coastal subsidence will be produced by a local rise of the high tide caused by change in the form of the shore line. If the bay narrows inland as shown in fig. 6, the tidal wave will increase in height as it advances, so that the level of high tide at the head of the bay will rise far above that of the open sea (*ED*, fig. 7). In this case all the trees between *A* and *E* will be killed at the head of the bay, and the appearance of subsidence will be unusually pronounced.

Fig. 8 represents the consequences of the opposite type of change. When the bay was open to the sea, the waves cut a cliff (*C*) and bench (*B*). But the construction of a barrier beach (*D*) has so

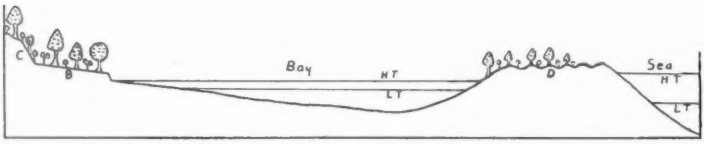

FIG. 8.—Diagram showing fictitious elevation of the coast; before the barrier beach (*D*) was constructed, the tide in the bay rose as high as in the open sea, and the cliff (*C*) and bench (*B*) were carved by the waves; since the building of the barrier beach, high tide (*HT*) in the bay is lower than in the ocean, the cliff and bench are no longer reached by the waves, and appear to represent an "elevated shore line"; the uniform altitude of the beach ridges on the barrier beach shows that the relative level of land and sea have long remained constant.

reduced the level of high tide in the bay that the waves no longer reach the cliff or the inner part of the bench. These become covered with trees and other fresh vegetation, and constitute what is usually called an "elevated shore line." Cliffs and benches of this origin have been cited as proofs of recent coastal elevation.

In applying the above principle to the interpretation of supposed elevations and subsidence of the land, the following points should be kept in mind:

a) If, instead of a sudden rupture of the barrier beach, we have a gradual enlargement of the inlet, the shores of the bay will appear to undergo slow and progressive subsidence. The gradual closing of an inlet, or the progressive shifting of its position, will likewise

cause the appearance of slow changes of level. Such changes are more common, but less striking, than those which are more sudden.

b) The total apparent subsidence produced in this manner may considerably exceed one-half of the tidal range in the adjacent sea. A considerable thickness of high tide salt peat may thus be produced without coastal subsidence.

c) Half-tide level does not necessarily remain the same after the change in high tide level.

d) The application of the principle here set forth is not restricted to bays of the type shown in fig. 6. Vast lagoons parallel to the coast, such as those of Long Island and New Jersey; open bays whose mouths are being widened by wave erosion; salt marshes traversed by meandering tidal channels; the intricate network of passes between the low and changeable islands of South Carolina and Georgia, or parts of the Holland coast; all these present favorable conditions for local changes of tide level consequent upon changes in the width, length, or depth of the tidal channels.

e) Many bays now open to the sea were once doubtless more or less nearly closed by barrier beaches. This is especially true along glaciated shores where the waves and currents have effected in post-glacial time, and are still effecting, comparatively rapid changes in the form of the shore line.

f) Appearances of subsidence predominate over those of elevation because marsh deposits tend to sink to the new level when high tide level is lowered; because the immediate destruction of fresh water vegetation by salt water when the high tide limit is raised is more striking than the slow recovery of marine area by fresh vegetation when the high tide level is lowered; and because in the cycle of shore line development retrograding exceeds prograding, and retrograding tends to carry higher tide levels into low lands where apparent changes of level are most easily recognized.

In order to determine how far conditions along the Atlantic coast were favorable to such future changes in high tide level as would produce apparent coastal subsidence, we made careful comparison of the height of the same high tide in partially closed bays, in lagoons, and in tidal creeks of salt marshes on the one hand, and in the ocean on the other hand, at a large number of

points along the coast from New Hampshire to Florida. The results of these surveys show that such favorable conditions occur abundantly along the entire coast. Differences of level in the high tide of the two contrasted water bodies amounting to nearly a meter were found, and from other surveys farther north it is known that still greater differences occur.

That such local changes of high tide level have occurred in the past is equally evident. At Scituate near Boston, the storm of 1898 made a large opening in a barrier beach which formerly nearly

FIG. 9.—Trees killed by local rise of high tide, near Scituate, Mass., giving fictitious appearance of coastal subsidence.

closed the mouth of a small bay. The high tide level immediately rose, according to the inhabitants, more than half a meter, and extensive areas of growing trees were invaded by salt water, the trees now standing erect but dead (fig. 9). Dikes built to reclaim portions of the former marsh surface are overflowed by the tides, and the marsh is building up to the new level.

In 1811 a break in a barrier beach a short distance to the south is said to have resulted in the death of many trees, the stumps of which have recently been extracted from the shallow shoreward portion of the marsh. At Cascumpeque Harbor, Prince Edward

Island, there have been several recent changes in the number and position of the tidal inlets connecting with the sea, and the inhabitants date the death of certain of their trees to a new inlet opened some years ago. Along the New Jersey coast the general surface of the marsh slopes downward toward the land, and on the Delaware Bay section of this shore the waves are cutting rapidly into the marsh, which is unprotected by barrier beaches. As a result of the consequent shortening of the meandering tidal creeks, the tides rise progressively higher and higher toward the heads of the creeks; the salt marsh builds gradually up to the new level of high tide, encroaching on the upland, killing the trees, and producing other evidence of progressive subsidence of the land. In the sea islands of South Carolina and Georgia we observed a number of more or less restricted localities where forests had been killed by a rise of high tide level following changes in size and position of tidal channels and bars, and one place where the death of the trees is dated from the cutting of a canal between two tidal channels. On the other hand, appearances of elevation of the land caused by a local lowering of the high tide level are not lacking. "Elevated" cliffs and benches of this origin were observed at a number of points on the coasts of Massachusetts, New Jersey, North Carolina, and Florida.

3. Phenomena due to remote subsidence

Frequent warnings have been uttered, most ably by SUESS, against the danger of confusing evidences of ancient changes of level with evidences of recent changes of level. Yet this error is found all too often in writings on this subject even today. Stumps deeply buried in the salt marshes are correlated with the invasion of cultivated fields by the tides; deeply buried salt peat is correlated with the dying of forests along the shore today; and on the basis of such correlations it is argued that we are in the presence of a great movement of subsidence which has continued uninterruptedly throughout recent time. It has even been argued that the embayed or drowned river valleys of the Atlantic coast are a conclusive proof of recent subsidence.

It is of the highest importance to recognize the possibility that deeply submerged stumps and peat, embayed valleys, and similar

evidence may have been produced by a downward movement of the land which entirely ceased thousands of years ago; and that they may be wholly unrelated to those evidences which may properly be designated as recent. Attacking the problem from this point of view, I have been unable to find a single evidence of recent change of level on the Atlantic coast which may not be reasonably explained either as a fictitious appearance of changes of level, or as the result of a local fluctuation in the level of high tide. On the other hand, I have been unable to find a single conclusive proof of a change of level which is not in all probability of considerable antiquity.

The best example of deeply submerged stumps which I have seen on the entire coast is that so well described by DAWSON[17] at the head of the Bay of Fundy. The position of these stumps indicates a veritable subsidence of the land, but they have been buried under the great thickness of silt since the embayment of the region, and have been brought to light again in recent time by a shifting of a tidal channel. The position of the more deeply buried portions of the salt peat under the salt marshes is most reasonably explained as the result of coastal subsidence; but this peat may well be of considerable antiquity and probably dates well back toward the early part of post-glacial time at least.

In closing this account of the relation of botanical phenomena to the problem of recent coastal subsidence, I desire to call attention to the application of some of the above considered principles to certain evidence lately presented by BARTLETT.[18] According to this author, a peat bog at Quamquisset Harbor, near Woods Hole, occupies a kettle hole and represents successive layers of vegetation continuously built up to the surface of a ground-water table which rose higher and higher as the land subsided. This subsidence required something over 2000 years, and is still in progress, the sea having recently cut into the bog deposit.

Irrespective of the question as to whether the Woods Hole

[17] DAWSON, J. W., On a modern submerged forest at Fort Lawrence, Nova Scotia. Quar. Jour. Geol. Soc. London **11**:119–122. 1855.

[18] BARTLETT, H. H., The submarine *Chamaecyparis* bog at Woods Hole, Massachusetts. Rhodora **11**:221–235. 1909; also Botanical evidence of coastal subsidence. Science N.S. **33**:29–31. 1911.

bog affords "incontrovertible evidence" of recent subsidence, as BARTLETT believes, that author is to be congratulated on having set forth in a clear manner the series of changes which will occur in a bog occupying a depression closed from the sea, on a coast which is really subsiding. But the particular case to which BARTLETT applies this principle seems to me unfortunate. In the first place, one must question whether the depression in which the bog deposit occurs is really a kettle hole. There are, to be sure, many kettle holes in the terminal moraine of this region; but the Quamquisset Harbor bog near Woods Hole appears to occupy a normal stream channel in drift which is probably older than the moraine, the channel having been somewhat modified by later ice action. Like many other similar channels which I have studied, this one was probably open to the sea, in which case the entire history of the bog must have been quite different from that imagined by BARTLETT.

Even if the depression were a kettle hole, the validity of BARTLETT'S argument must still depend upon three further assumptions, all of which seem to me open to question: (1) the *Chamaecyparis* stumps occur in place from the bottom to the top of the deposit; (2) coastal subsidence is the only theory competent to explain such a succession of stumps in place; (3) the lower as well as the uppermost layers of the deposit are of recent date (i.e., formed within the last 2000 or 3000 years). Stumps certainly occur in place near the surface of the bog, and extensive soundings verified the abundance of wood found by BARTLETT in depth. But all of the cores which I was able to bring up by numerous tests showed the grain of the wood transverse to the core, indicating that I had encountered only trunks, branches, or roots lying horizontally. Of course, the chances of encountering the end of an upright stump are not great, but the fact that a day's almost continuous sounding failed to discover an undoubted stump in depth shows how difficult it must be to prove that the bog consists largely of stumps *in situ*. BARTLETT presents no evidence of the existence of such stumps in depth, aside from the fact that he encountered buried wood. In a number of cases I determined the form of the buried wood by abundant closely spaced soundings, and invariably found greatly elongated pieces, evidently logs or branches.

Even if stumps occur in place throughout the deposit, they cannot be cited as incontrovertible evidence of subsidence until we make sure that nature can in no other manner produce such a succession of stumps in place. It has occurred to me that floating bogs bearing trees might sink as new accumulations of material in place would be carried downward to the bottoms of ponds or lakes. Several botanical friends to whom I have appealed tell me that buried stumps might well be produced in this manner. PENHALLOW[19] describes a bog which, according to his interpretation, has had such a history. Surely then we are justified in doubting the assumption that stumps in place deep down in a kettle hole bog are conclusive proof of a change in the relative level of land and sea.

But if we granted that the phenomena cited by BARTLETT could be accepted as a proof of coastal subsidence, we must still ask for some satisfactory evidence of the age of the lower part of the deposit before we can accept it as a proof of recent subsidence. The upper part of the deposit may well be of recent date, and yet not be the result of coastal subsidence. If any part of the deposit proves subsidence it is the lower part, which cannot have been affected by changes in tidal levels. But are we sure that this lower part is of recent date? Surely those familiar with the antiquity of some of the peat bogs of Europe, in which wood and other substances are still well preserved, will hesitate to affirm that the lower part of a given peat bog must be of recent date as here defined.

When critically examined, neither the botanical nor other evidence of recent coastal subsidence seems to me conclusive. On the other hand, the physiographic evidence, so far as I have been able to analyze it, indicates a long period of coastal stability. The evidence in favor of stability I have already briefly outlined elsewhere, and I will present a more detailed account of it in a forthcoming report on the Shaler Memorial investigation of shore line changes along the Atlantic coast.

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[19] PENHALLOW, D. P., A contribution to our knowledge of the origin and development of certain marsh lands on the coast of New England. Roy. Soc. Canada, Proc. and Trans. III. 1[4]: 33–34. 1907.

WESTERN PLANT STUDIES. II

AVEN NELSON AND J. FRANCIS MACBRIDE

PENTAMERIS.—As shown by PIPER in his Flora of Washington (Contrib. Nat. Herb. **11**:122), the name *Danthonia* is not available for the American species that have passed under that name. In choosing among the several later names that have been proposed, he selects *Merathrepta* Raf. in Seringe, Bull. Bot. **1**:221. 1830, apparently because the type species of the genus was *M. spicata*, an American species closely congeneric with ours. But will this fact permit our ignoring *Pentameris* Beauv. Agrost. 92. *t. 18* 1812, the type species of which is accepted as a *Danthonia*, as that genus has until lately been understood? Recent students of this genus recognize two sections, but so long as both remain as sections merely, all the species must be retained under the oldest available name that has had generic rank. This seems to be *Pentameris*, published as shown above, and attested by the many species subsequently referred to it. The types of the two sections are given along with the American species, and one other to show the synonomy.

PENTAMERIS THUARII Beauv. Agrost. 93. *t. 18*. 1812.—*P. tortuosa* Nees, in Linnaea **7**:311. 1832; *Danthonia tortuosa* Trin. Sp. Gram. *t. 68*. 1828–1836; not *D. Thuarii* Desv. Opusc. 99. 1831.

Pentameris provincialis, n. comb.—*Danthonia provincialis* DC. Fl. Fr. ed. 3. **3**:33. 1809 (?).

Pentameris americana, n. comb.—*Danthonia americana* Scribn. U.S. Dept. Agric. Circ. Agrost. **30**:5. 1901; *D. grandiflora* Philippi, Anal. Univ. Chile 568, 1873, not Hochst. 1851.

Pentameris californica, n. comb.—*Danthonia californica* Boland. Proc. Cal. Acad. **2**:182. 1863.

Pentameris compressa, n. comb.—*Danthonia compressa* Aust. Bull. Torr. Bot. Club **3**:21. 1872.

Pentameris epilis, n. comb.—*Danthonia epilis* Scribn. U.S. Dept. Agric. Circ. Agrost. **30**:7. 1901.

Pentameris grandiflora, n. comb.—*Danthonia grandiflora* Hochst. ex A. Rich. Tent. Fl. Abyss. **2**:418. 1851.

Pentameris intermedia, n. comb.—*Danthonia intermedia* Vasey, Bull. Torr. Bot. Club **10**:52. 1883.

Pentameris sericea, n. comb.—*Danthonia sericea* Nutt. Gen. Am. **1**:71. 1818.

Pentameris spicata, n. comb.—*Avena spicata* L. Sp. Pl. 80. 1753.

Pentameris thermale, n. comb.—*Danthonia thermale* Scribn. U.S. Dept. Agric. Circ. Agrost. **30**:5. 1901; *Merathrepta pinetorum* Piper. Contrib. Nat. Herb. **11**:122. 1906.

Pentameris unispicata, n. comb.—*Danthonia unispicata* Thurb. Bot. Cal. **2**:294. 1880.

Allium textile, n. n.—*A. reticulatum* Fraser in Mem. Wern. Soc. **6**:36. 1827; not *A. reticulatum* J. and C. Presl. Fl. Cech. 73. 1819.

Our collections made in 1912 show that this species has a wider distribution than heretofore assigned to it. Specimens having been secured on the Snake River, at Shoshone Falls, it seems probable that it may extend quite into eastern Oregon.

ALLIUM FIBRILLUM Jones, Contrib. Bot. **10**:24. 1902.—*A. collinum* Dougl. in Wats. Proc. Am. Acad. **14**:228. 1889; not *A. collinum* Guss. in Tenore Syl. Pl. Vas. Fl. Neap. 169. 1831.

PIPER, in his Flora of Washington, is undoubtedly right in citing the specimens of HORNER (nos. 190, 193, and 470) from the Blue Mountains (type locality) as representative of the heretofore poorly understood species published by WATSON for DOUGLAS.

Allium incisum, n. sp.—Bulbs large, 1–1.5 cm. broad, outer coats brown or pinkish, reticulation obscure: scapes 5–8 cm. high, stout, 1.5–2.5 mm. broad, narrowly winged: leaves 3–5 mm. broad, thick, and slightly falcate, attenuate to a long point, distinctly exceeding the scape, rather strongly nerved: spathe 2–several valved or at least one or all of the bracts deeply incised so as to appear distinct: bracts and their divisions ovate or broadly lanceolate at base, gradually long-acuminate, the margins of each often incurved and united near the tip: umbel globose, many-flowered: pedicels slender and flexuous, 1–2 cm. long: flowers white: segments shorter than the stamens, narrowly lanceolate,

acute, 1-nerved, not rigid but weak and crinkled in fruit: capsule very obscurely crested.

This species seems unique in its incised bracts. No. 1790 from barren gumbo clays, probably soft in the spring but becoming very hard, wholly devoid of other vegetation, House Creek, Owyhee Co., Idaho, June 29, 1912, is the type.

Calochortus maculosus, n. sp.—Bulb narrowly ovate, about 1 dm. below the surface, this and the underground part of the stem covered with coarse thick barklike coats: stems rather stout, smooth, 3–4 dm. high: leaves several (4–6), all abruptly expanded and scarious at the sheathing base: flowers 2, one on a spreading pedicel opposite the last bractlike leaf and also bracted; the other surmounting the main stem on a longer pedicel: sepals narrowly lanceolate, gradually long acuminate, 4–5 cm. long, greenish within and without: petals longer, 4.5–6 cm. long, abruptly acute and slightly crenate, white, or very pale blue, with a green band from apex to the large purple splotch above the yellow cuneate base, on which is the large gland, all the yellow area with long crinkled hairs: anthers 2 or 3-ribbed, obtuse, yellow, about equaling the filaments: capsule narrowly oblong.

This, the fourth member of the *macrocarpus* group, is easily distinguished from *C. bruneaunis* Nels. and Macbr., its nearest relative, by the hairy lower part of the petal and the color, and from the others by the large purple blotch. In aspect it somewhat resembles the *nitidus* group, from which the elongated capsule readily separates it. The characteristic green band and the few-ribbed anthers are some of the characters which forbid its being referred to the *Nuttallii* group. The type is no. 2727 by HENDERSON, in loose soil on the hills near Lewiston, Nez Perce Co., Idaho, June 17, 1894.

EPIPACTIS Adans. evidently cannot stand (see TORRE and HARMS Gen. Siph. nos. 1482 and 1504, and DRUCE's illuminating paper, Bull. Torr. Bot. Club **36**:543. 1909). But is *Helleborine* more truly available? This question it seems to us DRUCE has partly answered by his own arguments and statements of fact. We note that while *Helleborine* was in use before 1753, it was not published *with species* until DRUCE gives us the list that falls into the genus, restricted as now understood. DRUCE's aim was to bring his work into harmony with the Vienna rules, but these deny valid ty to *uninomial* nomenclature, a principle reasserted by the Brussels Congress. This seems long to have been an unwritten law, for we

are told that JOHN HILL'S work (British Herbal, 1756) remained unquoted even in the *Index Kewensis* because he had not adopted the *binomial* system. The only other name possibly available for the *Epipactis* of Adanson is *Limonias*, a name to be rejected primarily according to l w, because it is a name published without species, and secondarily in harmony with common sense, because it might result in confusion, ow ng to *Limonia*, a valid genus in the *Rutaceae*, and *Limonium*, a genus in the *Plumbaginaceae*. There seems to be no alternative, therefore, except to select a new name, and in recognition of the splendid work by OAKES AMES in the *Orchidaceae*, we have chosen the following, to which all the species listed by DRUCE are transferred.

Amesia, n. n.—*Epipactis* Adans. Fam. **2**:70. 1763, not *Epipactis* (Haller) Boehm. in Ludw. Definit. Gen. Pl. 1760, nor *Epipactis* Zinn, Cat. Pl. Hort. Acad. 85. 1757; *Helleborine* Hill and *Limonias* Ehrh. (see preceding paragraph).

Amesia africana, n. comb.—*Epipactis africana* Rendle, Jour. Bot. **33**:252. 1895.

Amesia atropurpurea, n. comb.—*Epipactis atropurpurea* Raf. Car. 87. 1810.

Amesia babianifolia, n. comb.—*Epipactis babianifolia* Roxb. Hort. Bengal. 63. 1814.

Amesia consimilis, n. comb.—*Epipactis consimilis* Wallich, Cat. no. 7403.

Amesia gigantea, n. comb.—*Epipactis gigantea* Dougl. in Hook. Fl. Bor. Am. **2**:202. 1830.

Amesia latifolia, n. comb.—*Epipactis latifolia* All. Fl. Pedem. 2:151; Sieb. in Sv. Vet. Akad. Nya Handl. 232. 1800.

Amesia microphylla, n. comb.—*Epipactis microphylla* Sieb. *loc. cit.*

Amesia orbicularis, n. comb.—*Epipactis orbicularis* C. Richt. Vehr. Zool.-Bot. Ges. Wien. **37**:190. 1887.

Amesia palustris, n. comb.—*Helleborine palustris* Schrank, Fl. Monac. **2**:190. 1814.

Amesia papillosa, n. comb.—*Epipactis papillosa* Franch. and Sav. Enum. Pl. Jap. **2**:519. 1879.

Amesia pycnostachys, n. comb.—*Epipactis pycnostachys* C. Koch, Linnaea **22**:289. 1849.

Amesia somaliensis, n. comb.—*Epipactis somaliensis* Rolf, Fl. Trop. Afr. **7**:189. 1897.

Amesia Thunbergii, n. comb.—*Epipactis Thunbergii* Perry, Exp. Jap. **2**:319. 1857.

Amesia trinervia, n. comb.—*Epipactis trinervia* Roxb. Fl. Ind. **3**:455. 1832.

Populus fortissima, n. n.—*P. angustifolia* James ex Torr. Am. Lyc. N.Y. **2**:249. 1828; not *P. angustifolia* Weinm. Elench. Hook. Palowsk. 451. 1824.

Salix columbiae, n. n.—*S. pyrifolia* Anders. Vet. Handl. Stockh. **6**:162. 1867; not *S. pyrifolia* Schleich, Cat. Pl. Helv. ed. **3**:26. 1815.

CARDIONEMA DC. Prod. **3**:372. 1828.—*Pentacaena* Bartl. in Presl. Rel. Haenk. **2**:5. 1830.

Cardionema ramosissima, n. comb.—*Loeflingia ramosissima* Weinm. Bot. Zeit **3**:608. 1820; *Pentacaena ramosissima* Hook. and Arn. in Hook. Bot. Misc. **3**:338. 1833; *Pentacaena polycnemoides* Bartl. in Presl. Rel. Haenk. **2**:5. 1830.

Cardionema camphorosmoides, n. comb.—*Pentacaena camphorosmoides* Walp. Rep. **1**:261. 1842.

Cardionema rosetta, n. comb.—*Pentacaena rosetta* Walp. *loc. cit.*

Cardionema congesta, n. comb.—*Pentacaena congesta* Benth. Pl. Hartw. 186. 1839.

Cardionema andina, n. comb.—*Pentacaena andina* Phil. in Anal. Mus. nac. Chile 26. 1891.

Aconitum Howellii, n. n.—*A. bulbiferum* Howell, Fl. N.W. Am. 25. 1897; not *A. bulbiferum* Reichb. Nebers. Acon. 55. 1819.

Ranunculus reconditus, n. n.—*R. triternatus* Gray, Proc. Am. Acad. **21**:370. 1886; not *R. triternatus* Poir. Encyc. Supl. **4**:662. 1815.

Arabis crypta, n. sp.—Biennial, stellate-pubescent throughout; stems one or two from the simple crown, branched above, 3 dm. high, greenish, the pubescence not so dense nor so perfectly stellate as that of the leaves and pods: basal leaves numerous, nearly linear, acutish, narrowed to a slender petiole, the midvein prominent, 2–3 cm. long; cauline distant, narrowly lanceolate, 3-nerved, slightly auriculate: flowers rather few, white or faintly tinted: petals 3–4

mm. long, scarcely twice the length of the green pubescent scarious-margined sepals: pods remote on the elongated rachis, white with the close pubescence, closely refracted at maturity, only 1–1.5 cm. long by 2 mm. broad or nearly that near the base, barely tapering to the apex: pedicels 2–3 mm. long: seeds few (2–6), orbicular, large, narrowly winged, uniserial or imperfectly biseriate.

Secured at Jarbridge, Elko County, Nevada, July 4, 1912; the habitat not noted.

Idahoa, n. n.—*Platyspermum* Hook. Fl. Bor. Am. **1**:68. 1830; not *Platyspermum* Hoffmann, Genera Plantarum Umbelliferum 58. 1814.

Idahoa scapigera, n. comb.—*Platyspermum scapigerum* Hook. *loc. cit.*

This peculiar and well known crucifer occurs sparingly in Washington, Oregon, and Idaho, but apparently is met with most frequently in western Idaho (from the Panhandle to Nevada), hence the choice of name.

Lepidium papilliferum, n. comb.—*L. montanum papilliferum* Henderson, Bull. Torr. Bot. Club **27**:342. 1900.—Biennial, densely papillose-pubescent, especially the stems; intricately branched, forming compact spherical clumps, consisting of a central stem with numerous lateral branches from its base to a point about one-third or one-half the height of the plant, where it in turn branches several times: lower leaves pinnatifid, even the uppermost deeply toothed: racemes short, dense: petals conspicuous, twice the length of the sepals: pods on slender, widely spreading, often even recurving pedicels, suborbicular, not at all narrowed to the notched apex, faintly glutinose-papillose: style well exserted.

No. 1068, Nampa, Idaho, distributed as *L. montanum* Nutt. is the type. No. 91, New Plymouth, and 880, Emmett, both by MACBRIDE and distributed as *L. Jonesii* Rydb., are typical.

L. papilliferum is distinguished at once from the species to which it has been referred by its distinctive habit of growth, its merely biennial duration and its unusual pubescence. *L. montanum* and *L. Jonesii* are perennial, the several stems spreading from a branched caudex, the plant possessing no main axis.

Lepidium philonitrum, n. sp.—Slender glabrate biennial with a slim tap root, 3–4 dm. high, the single sparingly branched stem simple below: leaves remote, the lower irregularly pinnate; the

cauline mostly trifid, the middle tooth the largest; the uppermost tridentate: flowers showy, the broad petals about twice the length of the sepals: fruiting pedicels slender, spreading, about three times the length of the pod: pod ovate, 3–4 mm. long by about 2 mm. broad, the narrow blunt apex slightly notched, the style less than twice the length of the scarcely involute apical wings.

No. 32, from alkaline bottom lands, Falk's Store, Idaho, May 17, 1910, by MACBRIDE, is the type. No. 2023 by CUSICK, near McDermitt, Oregon, may possibly be a pubescent form.

This is another member of the *alyssoides* group. Its pod allies it to *L. alyssoides* and *L. Jonesii;* its leaves to *L. papilliferum;* its aspect and habitat differ from all relatives.

Much has been made of differences shown by *Sisymbrium* and *Sophia* in the field, but, in common with many others, the writers are unable to see that each has vegetative characters so marked as to constitute generic differences. Believing that one genus should include them all, the following are transferred to *Sisymbrium*. In this connection it may be noted that *Descurainia* should replace *Sophia* only in the event that the latter is kept distinct.

Sisymbrium paradisum, n. comb.—*Sophia paradisa* Nels. and Ken. Proc. Biol. Soc. Wash. **19**:155. 1906.

Sisymbrium leptophyllum, n. comb.—*Sophia leptophylla* Rydb. Bull. Torr. Bot. Club **29**:239. 1902.

Sisymbrium ochroleucum, n. comb.—*Sophia ochroleuca* Woot. Bull. Torr. Bot. Club **25**:455. 1898.

Sisymbrium obtusum, n. comb.—*Sophia obtusa* Greene, Leaflets **1**:96. 1904.

COTYLEDON AND ITS SEGREGATES.—There being substantial agreement among botanists now in excluding the genus *Cotyledon* from this continent, the question arises as to the disposition of the species formerly referred to it and to *Echeveria*. This question has recently been answered by reestablishing *Echeveria* for a part and creating new genera for some of the more aberrant forms. It seems, however, that the differences relied upon to sustain some of these segregates are at best merely relative, and often inconsequential and unreliable, in this group. These characters are the shape of the leaves, the length or breadth of the corolla, its angulation and the

position of its lobes, characters good enough were they constantly found in one and never in another. Such, however, is not the case. For instance, the delimited *Echeveria* rests primarily upon its 5-angled corolla, but to *Dudleya* have been assigned species showing this character to some degree. In similar manner, the corolla of *Gormania* is said to be campanulate with spreading lobes, while in *Dudleya* it is tubular and the lobes erect. But in many of the species of *Dudleya* the tips of the lobes, at any rate, are spreading, while corollas occur in both to which the expression short-tubular or narrowly-campanulate might be applied with equal appropriateness. Thus, it appears that through the corolla of *Gormania*, at least, we are back to typical *Echeveria*. Since the characters thus overlap, it would seem best to refer all the species to the oldest genus, in accordance with which view some of the representative ones are here transferred.

ECHEVERIA DC.—*Gormania* Britton, Bull. N.Y. Bot. Gard. **3**:29. 1903; *Dudleya* Britton and Rose, *loc. cit.* 12; *Cotyledon* L. as to Am. Auth.; *Sedum* L. in part.

Echeveria Watsonii, n. comb.—*Gormania Watsonii* Brit. Bull. N.Y. Bot. Gard. **3**:29. 1903; *Cotyledon oregonensis* Wats. 1882; not *Sedum oreganum* Nutt.

Echeveria obtusata, n. comb.—*Sedum obtusatum* Gray, Proc. Am. Acad. **7**:342. 1868.

Echeveria debilis, n. comb.—*Sedum debile* Wats. Bot. King's Exp. 102. 1871.

Echeveria oregana, n. comb.—*Sedum oreganum* Nutt., in T. and G. Fl. **1**:559. 1840.

Echeveria Gormanii, n. n.—*Gormania laxa* Britton, Bull. N.Y. Bot. Gard. **3**:29. 1903; not *Echeveria laxa* Lindl. 1849.

Echeveria Brittonii, n. n.—*Gormania Hallii* Britton, Bull. N.Y. Bot. Gard. **3**:29. 1903; not *Dudleya Hallii* Rose, Bull. N.Y. Bot. Gard. **3**:17. 1903.

Echeveria Hallii, n. comb.—*Dudleya Hallii* Rose, *loc. cit.*

Echeveria Rusbyi, n. comb.—*Cotyledon Rusbyi* Greene, Bull. Torr. Bot. Club **10**:125. 1883.

Echeveria saxosa, n. comb.—*Cotyledon saxosum* Jones, Contr. West. Bot. **8**:28. 1898.

Echeveria nevadensis, n. comb.—*Cotyledon nevadensis* Wats. Bot. Cal. 1:212. 1876.

Echeveria plattiana, n. comb.—*Cotyledon plattiana* Jepson, Fl. West. Middle California 267. 1901.

Echeveria Palmeri, n. comb.—*Cotyledon Palmeri* Wats. Proc. Am. Acad. 14:292. 1879.

Echeveria Rosei, n. n.—*Echeveria Palmeri* Rose, Bull. N.Y. Bot. Gard. 3:10. 1903; not *E. Palmeri* (Wats.) Nels. and Macbr.

Echeveria lingula, n. comb.—*Cotyledon lingula* Wats. *loc. cit.* 293.

Echeveria Cotyledon, n. comb.—*Sedum Cotyledon* Jacq. Eclog. 1:27. 1811.

Echeveria Setchellii, n. comb.—*Cotyledon laxa Setchellii* Jepson, Fl. Middle California 267. 1901.

Echeveria Jepsonii, n. n.—*Cotyledon caespitosa paniculata* Jepson, *loc. cit.;* not *Echeveria paniculata* Gray, Pl. Wright. 1:76. 1852.

Aster siskiyouensis, n. n.—*Eucephalus glabratus* Greene, Pitt. 3:56. 1896; not *Aster glabratus* Kuntze.

Aster perelegans, n. n.—*A. elegans* T. and G. Fl. 2:159. 1842; not *A. elegans* Willd.

Aster kootenayi, n. n.—*A. Cusickii Lyallii* Gray, Syn. Fl. 1:195. 1884; not *A. Lyallii* Kuntze.

Chaenactis Mainsiana, n. sp.—Low tufted perennial from a slender woody caudex, more or less branched upward: stems few, decumbent, naked-pedunculate above: leaves clustered toward the base, 3–5 cm. long, including the slender winged petiole, oblanceolate to obovate in outline, once or rarely twice pinnatifid or parted into blunt oblong or spatulate lobes, greenish-gray with a minute lepidote tomentum, sprinkled with resinous atoms: peduncles floccosely-pubescent, exceeding the leaves by 5–10 cm., bearing one or often two heads and then subtended by an entire or parted bract: heads 1–1.5 cm. high: bracts oblong, obtuse, sometimes with one or two shorter and spreading ones: pappus-paleae oblong, obtuse, more than half the length of the flower: achene brown, sparingly soft-pubescent, about 6 mm. long, distinctly longer than the pappus.

This is allied to *C. nevadensis* (Kell.) Gray and *C. Evermannii* Greene, but both of these are dwarf alpine plants with monocephalous peduncles scarcely exceeding the leaves, which show a tendency to be more or less pedately parted and flabelliform. In both the leaves are white with tomentum (at least when young), and the achenes are densely silky-pubescent.

Dedicated to the Supervisor of the Payette National Forest, G. B. MAINS, who is each year adding much to the knowledge of his district by the excellent specimens prepared by him and his associates. The type is no. D-34, from the Payette National Forest.

Tonestus linearis, n. sp.—Branches of caudex very slender, brown with remnants of dead petioles: leaves narrowly linear, slightly broadened upward, subacute, 3-nerved, minutely crisped-pubescent, 2–4 cm. long (including the petiole-like base): stems very slender, few-leaved, about 10 cm. long: heads as high as broad; bracts linear, about 10 mm. long, subequal, softly herbaceous, with narrow scarious margins, in two rows, with one or more looser outer ones: rays 10–15, broadly linear, a half longer than the disk; disk flowers more numerous: achene narrowly oblong-cylindric, minutely pubescent.

This new species illustrates the generic characters perfectly, yet by its slenderly linear parts throughout is quite distinct from *T. pygmaeus* and *T. Lyallii*.

Secured by G. B. MAINS, Supervisor Payette National Forest, 1912.

Balsamorrhiza rosea, n. sp.—Low, acaulescent from a short, thick warty root crowned with leaf bases: leaves somewhat cinereous with a rather long fine but stiff pubescence, including the short petioles 4–10 cm. long, irregularly pinnately divided, the broad short blunt divisions coarsely toothed: scapes few, monocephalous, the pubescence longer and looser than that of the leaves, about 1 dm. high, bearing at base a pair of linear acute bracts 1 cm. long, with scarious clasping bases: heads 3–4 cm. broad, the very crowded persistent or very tardily deciduous rose or purplish rays oval, crenately and irregularly few-toothed at the summit, pubescent with long soft hair, especially on the prominent parallel veins beneath and around the short tube: bracts lanceolate, acute, rather loose, the outer shorter, densely ciliate with long glistening soft pubescence, that of the surface somewhat appressed: chaff of the receptacle broadly scarious-margined three-fourths of the length,

the scarious portion fimbriate at its junction with the herbaceous ciliate tip: ray achenes somewhat compressed, carinate on both sides, hirsute near the top, the pubescence shorter and sparser downward, those of the disk similar but glabrous or nearly so except for the ciliate summit.

This is the second member in the section KALLIACTIS Gray. No. 568 by J. S. COTTON, from rocky ridges of the Rattlesnake Mountains, Yakima County, Washington, May 8, 1902, is the type.

Balsamorrhiza serrata, n. sp.—Low, acaulescent, from a thick short tuber-like root: leaves crowded on the small crown, green but appressed pubescent with minute rigid hairs, the short petioles enlarged and sheathing at base, the blades 3–8 cm. long, much exceeding the petioles, strongly veined, ovate, sharply and closely serrate, the cuspidate teeth longest at the middle, diminishing toward the acute tip and the subcordate base: scapes few (1–3), 1–2 dm. high, monocephalous, naked, or sometimes with a pair of opposite long-petioled laciniately cleft or serrate leaflike bracts below the middle, the pubescence spreading, of two kinds, a fine dense indument and a soft long hirsute form which becomes most pronounced at the base of the heads and on the bracts: heads 4–6 cm. broad, the numerous yellow rays about 3.5 cm. long; bracts linear or linear-lanceolate, acute or acuminate, of nearly equal length: chaff of the receptacle little shorter than the flowers: disk achenes very flat, faintly nerved on each side of the low carinate ridge.

Perhaps nearest *B. deltoidea* Nutt. No. 83 by J. B. LEIBERG, from Morrow County, Oregon, May 19, 1894, is the type. Equally representative is his no. 58 from the same county, May 12, 1894.

ROCKY MOUNTAIN HERBARIUM
UNIVERSITY OF WYOMING, LARAMIE

CHEMICAL AND PHYSICAL CHANGES IN GEOTROPIC STIMULATION AND RESPONSE

CONTRIBUTIONS FROM THE HULL BOTANICAL LABORATORY 179

EVA O. SCHLEY

(WITH SIX FIGURES)

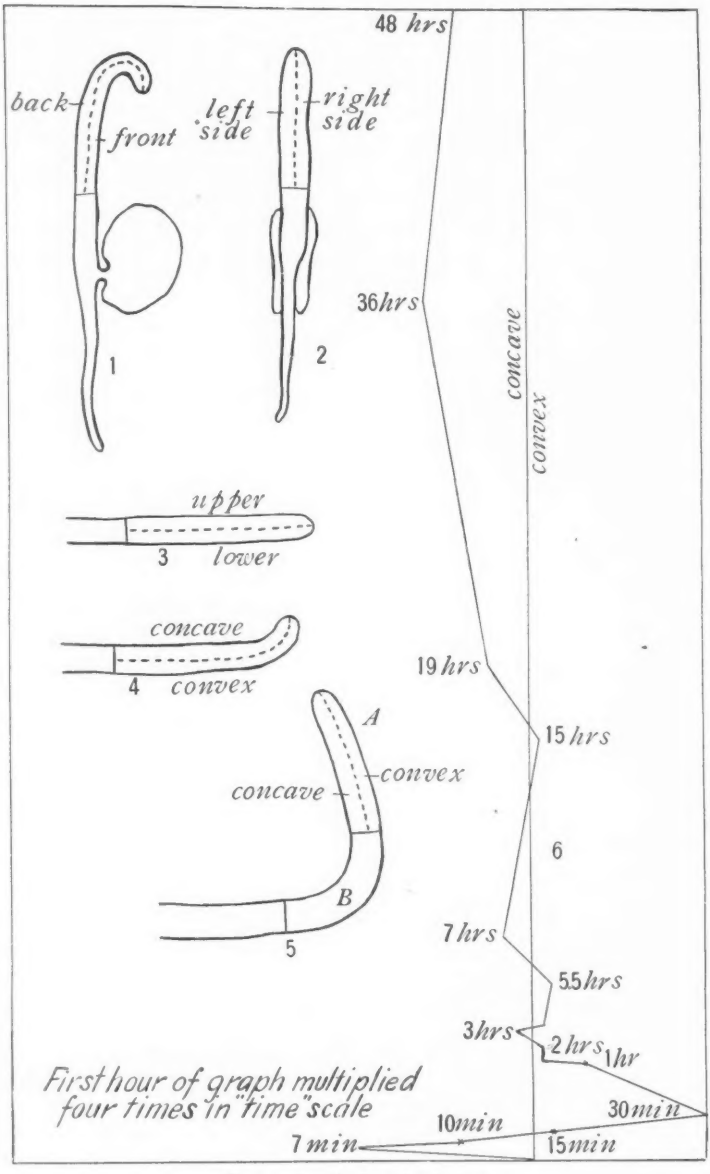
Considerable work has been done on chemical-physical changes involved in tropic presentation and reaction. KRAUS (1) was probably the first worker in this field. His researches include the determination of (*a*) the sugar content of the growing shoot, (*b*) the relation of the sugar maximum to the growth maximum, (*c*) acidity in the growing shoot, and (*d*) steps in the change of the cell-content of the two halves (the shoot was split longitudinally into the concave half, the inside of the curved portion, and convex half, the outside of the curved portion, of the responded organ) of the shoot exposed to geotropic or heliotropic stimuli during perception and reaction time. He found that (*a*) the sugar in the growing shoot increases for a certain region from above downward and then decreases, (*b*) the sugar maximum lies below the growth maximum and consequently is not the limiting factor in growth, (*c*) the acidity is greatest in the tip and decreases downward. In geotropically and heliotropically stimulated shoots he found, first, decreased acidity and increased sugar on the convex side, later, an increase of water and decrease of sugar on the convex side, followed by a decrease of acidity on this side.

CZAPEK (2) working with geotropically stimulated roots found an interference with the oxidation of tyrosin and phenylalanine which led to the production of homogentisic acid. GROTTIAN (3) and GRAFE and LINSBAUER (4) were unable to confirm his results. MARTIN FISCHER (5) has shown that the water-absorption power of colloids is increased by the addition of acids and alkalies up to a certain concentration, and that salts decrease this power. PROMSY (6) has found that organic acids increase the growth rate of seedlings. RAVIN (7) likewise found that acids increase the rate of

elongation in growing plant organs. ECKERSON (**8**) has shown that acids decrease the period of after-ripening of certain dormant seeds. The activity of these acids on germination is due in part to the transformation of zymogens into active enzymes and to favoring the activity of those enzymes. In both germination and growth it is probably partly due to increasing the water-absorbing power of the colloids, especially of the protoplasm.

In view of the effect of acidity on the absorption of water and on the growth rate, it was thought best to reexamine the two halves (concave and convex) of geotropically stimulated and responding organs for difference in acidity, and incidentally for other features such as the sugar content. Following FISCHER'S suggestion, it was thought that relative growth on the two sides might parallel the acidity. A later work will examine into this condition of tropic and nastic responses, and a later paper will relate the data more fully to the literature.

Etiolated seedlings grown upright on boards under a spray have been used throughout the experiment. The temperature maintained was approximately 16° C. When the seedlings were 6–8 cm. high, they were used in making tests of acidity upon either the unstimulated or the stimulated organ. For the latter tests the board containing the seedlings was turned on the side so that the seedlings were brought at right angles to gravity. Tests for acidity were made at various intervals of presentation and reaction time, ranging from 7 minutes to 48 hours. In making the tests on the unstimulated shoots, the vertical stem was split longitudinally into right and left halves (in the plane of the cotyledons), and also into back and front halves (at right angles to the plane of the cotyledons) (figs. 1 and 2). For the tests on the geotropically stimulated seedlings the shoots were split longitudinally into upper and lower halves, the former being the half away from the direction of the stimulus and the latter the half next the direction of the stimulus. After reaction these showed as concave and convex halves respectively. These terms hold throughout the paper (figs. 3 and 4). The terminal 4.5 cm. was used, since this region included the region of curvature and since tests on acidity in successive centimeters from the tip downward showed the maximum acidity to be included



FIGS. 1–6.—Explanation in text

in this portion. The cut seedlings were weighed in weighing-bottles and the weight obtained by difference. Samples of 6–8 gm. were used.

Immediately after weighing, the samples were cut up fine and ground to a pulp in a mortar. Several methods of titration were used. In the first method employed, about 50 cc. of distilled water were added to the ground-up tissue and the sample titrated at once without filtration, using phenolphthalein or neutral red as indicator. The objection to the method is that reaction between the acid yet in the tissue with the alkali is slow yet continuous, so that the end point is not definite. A second method used was the test plate method. The tissue was ground as before, filtered through glass wool, and the filtrate refiltered through asbestos over a filter pump. The tissue together with the glass wool filter was again triturated and washed quantitatively into the filtrate previously obtained and the volume made up to 100 cc.; 10 or 25 cc. were used in a titration and the average of several titrations used in calculation. The end point was determined by means of phenolphthalein in the following way. Two solutions of phenolphthalein were prepared. The first was prepared by adding 10 drops of an alcoholic solution of phenolphthalein to 25 cc. of distilled water. The second solution contained in addition 3 drops of a $n/20$ solution of NaOH, enough to make the solution a decided pink color. A few drops of each solution were placed on a test plate and the sample being titrated tested by introducing a small quantity on the end of a small stirring rod into each of the solutions of phenolphthalein. The end point was reached when the sample introduced just failed to neutralize the small amount of alkali in the one solution, as indicated by the faint pink color remaining, and just showed a faint pink tinge in the other solution. In this way the end point was not obscured by the color of the solution. The method finally adopted was that of using the natural indicator in the plant itself. It has been observed in the course of both animal and plant tissue analysis that chromogens develop when certain fractions, as the lipoid fraction, are neutralized. This suggested the idea that possibly the raw material upon neutralization might show a change of color which could be used as an indicator. The reliability of the natural

indicator was tested on several different plants. The results of the experiment are given elsewhere in this paper.

In the case of *Vicia Faba* the material was prepared as in the test plate method; 10–25 cc. of the solution were placed in a porcelain dish and titrated with a $n/10$ solution of sodium hydroxide. The solution was at first grayish opalescent. It gradually changed during titration, assuming a yellowish color. Upon neutralization the solution turned the color of the testa of the ripe *Vicia Faba* seed. Excess of sodium hydroxide does not change the color. Upon standing 15–30 minutes, however, the neutralized solution becomes dark brown.

The work on acidity included (*a*) tests on the region of greatest acidity in the shoot, (*b*) tests on the right and left halves and back and front halves of the unstimulated shoot, and (*c*) tests on the upper and lower (concave and convex) halves of the geotropically stimulated shoots. The following table will give illustrations of the data obtained in experiments *a* and *b*. The first table gives

TABLE I

Vicia Faba shoots in 0.5 cm. lengths from tip downward

1st 0.5 cm	1.30 cc.	per g. wt.
2d 0.5 cm	1.25 cc.	" " "
3d 0.5 cm	1.07 cc.	" " "
4th 0.5 cm	0.84 cc.	" " "

TABLE II

Vicia Faba SHOOTS; TERM. 4.5 CM. USED

Right half	Left half	Front	Back
0.77	0.71	0.91	0.92
0.88	0.88	0.84	0.83
0.89	0.89	0.98	0.94
0.70	0.67	0.77	0.78
Av. 0.80	0.78	0.87	0.87

results for tests on acidity in 0.5 cm. lengths from the tip downward. The second table shows the acidity of the unstimulated shoots cut longitudinally into right and left halves and front and back halves (figs. 1 and 2). The results as given in table I show decreased acidity from the tip downward, which accords with the work of

KRAUS. Table II is given merely to show the probable error in titration in the following acidity tests of the stimulated shoots.

Table III shows results of titration of the geotropically stimulated shoots at varying intervals of time corresponding to the periods of maximum acidity and to the period of equal acidity of the concave and convex halves.

TABLE III

Vicia Faba SHOOTS GEOTROPICALLY STIMULATED; TERMINAL 4.5 CM. USED
NO. CC. PER GRAM FRESH WT.

Time stim.	Concave half	Convex half	Diff. in acidity
7 minutes	0.942	0.715	0.237
10 "	0.622	0.469	0.153
15 "	0.623	0.683	0.060
30 "	0.900	1.210	0.300
60 "	1.07	1.19	0.13
2 hours	1.01	1.02	0.01
17 "	0.512	0.515	0.03
38 "	0.884	0.782	0.102
48 "	0.671	0.589	0.072

From the tables it will be noticed that the geotropically stimulated shoot first increases in acidity in the upper (concave) half, the observed maximum being 7 minutes. After the maximum the acidity of the concave side rapidly diminishes, passing a period of about equal acidity in 15 minutes. The convex side more slowly approaches a maximum acidity, reaching it in 30 minutes. After the maximum the two sides gradually become equal in acidity until at the time of visible response, about two hours, they are practically equal. This equality in acidity continues through the period of curvature till the plant has passed the vertical, when the concave side again becomes more acid (for these titrations only the curved portion which had passed the vertical plane were used; fig. 5, *A*). As the shoot straightens again, the acidity decreases on the concave side. The accompanying graph (fig. 6) gives the average of several experiments for each time indicated.

Since this method measures the titration value but not the H-ion content of the acid, the results are not directly comparable with the work of FISCHER, whose conception, besides the acid change, involves also changes in the amount of salts and the nature

of the colloids, which have not been undertaken in this work. So far as the results indicate, however, they show no difference which would explain curvature on the basis of increased acidity, since at the time visible curvature begins the two flanks are of equal acidity.

In testing the natural indicator of the plant, the tissue was prepared as described above for *Vicia Faba;* 25 cc. of the filtrate were used in titration and several duplicate titrations made. Table IV serves to show the accuracy of the titration and to give the color reaction.

TABLE IV

Tissue used	No. cc. n/10 NaOH to neut. 25 cc. sol.			Color unneut. sol.	Color neut. sol.
Mucor (young)	0.13	0.13	0.12	Faintly greenish	Color ripe spores
Wax beans.....	0.36	0.36	0.40	Opalescent	Pale canary yellow
Ripe apple.....	1.61	1.65	1.60	Pale cider	Dark orange
Lemon juice.....	14.80	14.75	14.75	Lemonade	Color lemon rind
Lemon rind.....	0.26	0.23	0.28	Lemon rind	Orange rind
Orange juice.....	2.12	2.18	2.14	Dilute orange juice	Orange rind
Orange rind.....	0.29	0.30	0.30	Pale orange	Deep orange
Etiolated seedlings—					
Corn.....	0.46	0.46	0.44	Faintly yellow	Orange yellow
Sweet peas	0.40	0.41	0.40	Opalescent	Canary yellow
Sunflower.....	0.23	0.23	0.20	Dull brownish yellow	Bright greenish yellow
Vicia Faba	0.71	0.72	0.70	Faintly grayish	Color ripe seed

Neutral red and phenolphthalein were used with the test plate as checks in determining the accuracy of the indicator. The neutral point is reached when a drop of the alkali fails to produce a change of color in the solution. It is interesting to note that the color produced in neutralization is usually the color of some part of the seed or plant. In *Vicia Faba* this similarity is striking. Solutions of the triturated coat are neutral. The chromogens produced in all of the solutions neutralized were precipitated in 24–48 hours.

Only one sugar titration has been made. For this analysis the etiolated seedlings were grown in sand in the greenhouse at a temperature of about 16° C. When the seedlings were 6–8 cm. high, they were geotropically stimulated for 30 minutes and the terminal 4.5 cm. used in the analysis. The gathering required

half an hour, so that the average stimulation was 45 minutes. After weighing, the two halves (upper and lower) were placed in 85 per cent alcohol heated to 70° C., and allowed to stand for two weeks. The material was then cut up fine and extracted 48 hours in an extractor similar to the Soxlet extractor. The extract together with the alcohol used in preserving the material was evaporated to moist dryness over the steam bath and brought to constant weight *in vacuo*. The dried material was dissolved in water, 10 cc. of concentrated hydrochloric acid and 20 cc. of chloroform added, and the whole made up to 1000 cc. in volume. The water-soluble portion was filtered from the chloroform-soluble or lipoid fraction and the sugar determination made upon it directly. The lipoid fraction was dissolved in alcohol, and made up to 500 cc. in volume; 50 cc. of each fraction was used in the determination. The fractions were hydrolized and the tannin precipitated before testing for sugar. The method of hydrolysis used was that described in *Bulletin no. 107*, p. 41, U.S. Dept. of Agric., Bur. of Chem. The tannin was precipitated after hydrolysis by means of lead acetate and sodium sulphate. The sugar was determined by the cuprous oxide method as described in the above mentioned bulletin (p. 242). The amount of cuprous oxide was determined by the volumetric potassium permanganate method (*ibid.* pp. 52, 53). An *n*/20 solution was used. The calculations were based on the mg. of copper oxidized in the change from cuprous to cupric oxide, and the invert sugar equivalent obtained from the accompanying table (p. 243). Table V shows the results obtained.

TABLE V

Flank	Fresh wt.	Dry wt.	Amt. sugar	Percentage fresh wt.	Percentage dry wt.
Concave.....	231.635	11.2994	2.7763	1.198	24.50
Convex	242.275	11.8064	1.9202	0.792	16.26

These results differ from those of KRAUS in point of time of stimulation. He found the sugar content on the convex side to increase during the period of one hour and then to decrease. The experiment given shows an increase of 0.406 per cent of the fresh

weight and 8.24 per cent of the dry weight on the concave side of seedlings stimulated 45 minutes.

The dry weight of the curved portion of the shoot (fig. 5, *B*) was determined for various times of stimulation. The material was split into concave and convex halves, weighed, and dried to constant weight in an electric oven at a temperature of 104° C. The differences obtained, while slight, are significant in that they vary in the same direction. Table VI explains itself.

TABLE VI

Time stim. days	Fresh wt. concave grams	Fresh wt. convex grams	Dry wt. concave grams	Dry wt. convex grams	Percentage dry wt. concave	Percentage dry wt. convex	Diff.
2.5.....	22.0139	26.6482	1.2480	1.4234	5.44	5.34	0.09
3.0.....	17.0296	20.8236	.9202	1.0746	5.43	5.16	0.17
4.0.....	54.1735	62.2810	2.8621	3.1524	5.20	5.06	0.14

Summary

1. The acidity of the growing shoot is greatest at the tip and decreases downward.

2. The relative acidity of the two flanks of the geotropically stimulated shoots changes during presentation and reaction time. First the concave side becomes relatively more acid, then decreases until the maximum acidity comes to lie on the convex side. The two flanks now gradually become equal in acidity, this period coinciding with the time of visible curvature. This equality in acidity is maintained until the tip of the shoot has passed the vertical plane, when the concave side again becomes more acid. As the shoot straightens, the difference in acidity decreases.

3. The increase of acidity does not parallel the relative rate of growth on the two flanks.

4. Several plants examined develop in neutral solution a chromogen which acts as a delicate acid-alkali indicator.

5. The percentage of dry weight is greatest on the concave side.

The writer is indebted to Dr. F. C. Koch for suggestions in the method of sugar analysis.

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STUDIES IN THE GENUS BIDENS. I

CONTRIBUTIONS FROM THE HULL BOTANICAL LABORATORY 180

EARL E. SHERFF

In the prosecution of taxonomic researches upon the different species of *Bidens*, the writer has found several species either apparently undescribed heretofore or bearing names no longer tenable. This article will deal mainly with some of these cases. A list of the various herbaria and libraries consulted thus far, and of the several botanists who have kindly rendered assistance in this work, will be deferred until a later time.

Bidens Deamii, sp. nov.—Herba annua, plus minusve pallida, 3 dm. alta, caule profunde ramoso; ramis subglabris, subtetragonis, striatis, inferioribus arcuato-adscendentibus, ramulis monocephalicis. Folia opposita, petiolata, petiolo adjecto 1–2 cm. longa, tri-(aut pinnati-)partita, subglabra; foliolis terminalibus trilobatis, cuneatis; foliolis lateralibus integris aut dentatis; dentibus et lobis submucronatis, integris. Petioli 3–8 mm. longi, submarginati, hispido-ciliati. Capitula terminalia, longe pedunculata, subcorymbosa, pedunculis adscendentibus aut erectis, 1.5–2 cm. lata, ligulata. Involucrum basi hispidum; squamis duplici serie dispositis; exterioribus linearibus, subviridibus, ciliatis; interioribus paulo longioribus, lanceolatis, margine diaphanis. Ligulae albae aut subroseae, striatae, 8–12 mm. longae. Achaenia linearia, sulcata, spinulosa, biaristata aristis retrorsum hamosis, nigra aut versus apicem fusca, interiora demum plus minusve attenuato-rostrata et 1.2 cm. longa.

Chas. C. Deam, Cholula, Mexico, January 1, 1899 (type in Herb. Field Mus.); *Rose, Standley*, and *Russell* 13405, in vicinity of San Blas, Sinaloa, Mexico, March 24, 1910.

A species approaching, in its sometimes slightly beaked achenes, the genus *Cosmos*, but otherwise showing stronger affinities with *Bidens*.

Bidens parvulifolia, sp. nov.—Herba caule adscendente aut plus minusve repente, subsimplice, longo 1.5 dm. plusve, subpiloso aut subglabro, tetragono. Folia opposita, petiolata, ovata, acuta

aut subacuminata, serrata (aut summum jugum trifoliatum lobis serratis), pubescentia, petiolo adjecto 1.5–2.5 cm. longa. Petioli 6–8 mm. longi, ciliati, pilosiusculi. Capitula terminalia, longe pedunculata, 3 cm. lata. Involucrum basi hispidulum, squamis duplici serie dispositis; exterioribus linearibus, glabris; interioribus longioribus, lanceolatis, margine diaphanis. Ligulae flavidae (in specim. exsicc.), striatae, 1.2 cm. longae. Achaenia matura absentia. Ovaria biaristata, aristis retrorsum hamosis.

Heyde and *Lux* 6163, Guatemala, 1894 (type in Herb. Univ. Chicago); *eidem* 6162, Fraijanes, Depart. Amatitlan, Guatemala, alt. 900 m., September 1893.

Bidens ramosissima, sp. nov.—Herba annua, pallida, ramosissima, 3–5 dm. alta; ramis tenuibus, oppositis, sulcatis, subglabris aut hispidis; ramulis monocephalicis. Folia petiolo adjecto 8–15 mm. longa, tri-(aut pinnati-)partita; foliolis integris aut trilobatis, 1–7 mm. longis, acutis, base angustis aut cuneatis; petiolis 2–4 mm. longis, ciliatis et nonnullis hispidis. Capitula terminalia, subcorymbosa, longe et tenuiter pedunculata, ligulata, 1–2 cm. lata. Involucrum basi hispidum, demum reflexum, squamis duplici serie dispositis; exterioribus linearibus, ciliatis, apice plus minusve dilatatis, mucronatis, 3 mm. longis; interioribus subglabris, lanceolatis, margine diaphanis, 4–5 mm. longis. Ligulae albae aut apice subviolaceae, obovatae, striatae, truncato apice 3–5 dentato dentibus obtusissimis, 6–8 mm. longae. Paleae lineares, 4 mm. longae. Achaenia linearia, sulcata, biaristata, margine et lineis mediis scabrido-hispida, 8–10 mm. longa; aristis retrorsum hamosis.

W. E. Safford 1391, near Guadalajara, Jalisco, Mexico, February 23, 1907 (type in U.S. Nat. Herb.).

A species suggestive of *B. Deamii*, but differing in the finally reflexed involucres and the more slender, highly subdivided branches. It is one of the several species of *Bidens* that approach too closely, in color of rays or beaked achenes, the genus *Cosmos*. However, distinctly rostrate achenes are absent in the type, and the involucre, furthermore, is that of a true *Bidens*. On label said to have the common name "accitillo."

Bidens mexicana, sp. nov.—Herba caule scandente, ramoso, tereti, striato, glabro. Folia opposita, petiolata, pinnati-(aut bipinnati-)divisa; foliolis aut laciniis submembranaceis, serratis,

glabris aut subciliatis; lateralibus petiolulatis aut subsessilibus, lanceolatis aut ovato-lanceolatis, attenuatis, 2–6 cm. longis; terminale plus minusve petiolulato, lanceolato-attenuato, apice anguste acuminato, basi subcuneato, 4–6 cm. longa. Petioli 1.5–4 cm. longi, glabri, angusti, basi dilatati et connati. Capitula plurima, corymbosa aut paniculato-corymbosa, pedicellata, 6–7 mm. alta, 5–7 mm. lata. Involucrum squamis duplici serie dispositis; exterioribus linearibus, glabris, squarrosis aut reflexis, 3 mm. longis; interioribus lanceolatis, striatis, margine diaphanis, glabris aut apice minute pubescentibus, 4–5 mm. Ligulae flavae, striatae, 8–10 mm. longae. Paleae lineare-lanceolatae, striatae, glabrae aut apice subglabrae, 5 mm. longae. Achaenia nigra, biaristata, margine tuberculato-hispida, 7–9 mm. longa, aristis squarrosis aut recurvis.

Dr. Edward Palmer 95, in or near Acapulco, Mexico, October 1894 to March 1895 (type, with the flowering and the fruiting specimen on two separate sheets, in Herb. Univ. Chicago).

An interesting species, allied to *B. reptans* (L.) G. Don and *B. tereticaulis* DC., but apparently related even more closely to *B. Urbanii* Greenman. Various specimens of this number elsewhere in the United States show a considerable range of variation in leaf texture and outline; but the flowering *type* specimen exhibits leaves strikingly close to those of *B. Urbanii* Greenman (see *B. dissecta*, below), of which this species may be the Mexican representative.

Bidens Brittonii, sp. nov.—Herba caule scandente, striato, ramis oppositis, 2–4 m. alto. Folia petiolo adjecto 3–9 cm. longa, pinnata; foliolis dentatis incisis aut pinnatisectis, supra pubescentibus, subtus tomentosis, 0.8–2 cm. longis; petiolis et mediis nervis ciliatis. Capitula corymbosa, breviter pedunculata, ligulata. Involucrum 4–6 mm. altum, 5–6 mm. latum, squamis inter se subaequalibus, duplici serie dispositis; exterioribus lineari-spatulatis, ciliatis, nonnullis pubescentibus; interioribus linearibus, apice pubescentibus et angustioribus, margine diaphanis. Ligulae flavae, anguste obovatae, non apice dentatae, 1.5 cm. longae. Paleae lineares, apice pubescentes, 6–8 mm. longae. Achaenia linearia, striata, biaristata, margine tuberculato-hispida.

C. Wright 314 *pro parte*, eastern Cuba, 1856–1857 (type in Gray Herb.).

The achene characters are drawn from a fruiting specimen (also collected by WRIGHT, 314) in the Columbia College Herbarium. This specimen, as also

the one at the Gray Herbarium, was mounted upon the same sheet with a specimen of *B. reptans* (L.) G. Don. On the sheet was written, evidently in TORREY's handwriting, "2 species!"; while just below, GRAY had written, "no, A. Gr." In his diagnosis of WRIGHT's plants, GRAY treated this form as a variety of *B. reptans* with dissected leaves. But the fact that the leaves are pubescent above and strongly tomentose beneath, as well as finely dissected, makes it seem certain that two different species have been confused, and that TORREY's assumption was correct. The species is here named in honor of Dr. N. L. BRITTON in grateful recognition of his assistance, upon this and several related species, in supplying data from his widely extended field knowledge of West Indian plants.

Bidens dissecta, comb. nov.—*B. reptans* (L.) G. Don, var. *dissectus* O. E. Schulz, Urb. Symb. Antill. **7**[1]:142. 1911.

A Jamaican plant similar to the Porto Rican *B. Urbanii* Greenman, but with more finely divided leaves; also to the Cuban *B. Brittonii*, but with the more finely divided leaves not tomentose beneath. These three species, while perhaps congeners at a remote period in the past, and certainly related to *B. reptans* (L.) G. Don, are, in my opinion, clearly entitled to specific rank and should be classed as separate species. They seem quite distinct from even the most closely approaching forms of the highly variable *B. reptans* (L.) G. Don, many specimens of which I have seen at the New York Botanical Garden, through the courtesy of Dr. BRITTON.

Bidens anthemoides, comb. nov.—*Coreopsis anthemoides* DC. Prodr. **5**:573. 1836.

ASA GRAY (Proc. Amer. Acad. **19**:15. 1884) carefully considered this species, but retained it in *Coreopsis*, the taxonomic distinctions between which and *Bidens* he admitted frequently in his writings to be highly artificial. But since the days of DE CANDOLLE and GRAY, botanists have very correctly inclined toward separating these two genera according to the sum total of the characters of each species. In the several transfers consequently made, notably by BRITTON (Bull. Torr. Bot. Club **20**:280–281. 1893), this and the following species seem to have been overlooked. It is interesting to note, however, that C. H. SCHULTZ BIPONTINUS had given, previous to GRAY's observations, the names *Bidens coreopsidioides* (not *B. coreopsidis* as in Gray, *loc. cit.*) and *Bidens Schaffneri* to specimens of this species sent to the Gray Herbarium.

Bidens Schaffneri, comb. nov.—*Coreopsis Schaffneri* A. Gray, Proc. Amer. Acad. **19**:15. 1884.—A perennial species allied with *B. angustissima* H. B. K., *B. procera* Don. and even *B. ludens* Gray.

Evidently placed in *Coreopsis* by GRAY merely because of the practically smooth awns of the achenes. In general habit, also in the shape of the achenes

(which are tetragonal and lack wings), GRAY's type is a true *Bidens*. The associate types collected by PARRY and PALMER (488 and 488½, not "448 and 448½" as erroneously printed in GRAY's original citation), in the Gray Herbarium, match very well SCHAFFNER's no. 202, the type. The name here given for this species should not be confused with the same name given years ago by SCHULTZ BIPONTINUS to *B. anthemoides* on a herbarium label, but never published by him.

BIDENS TENUISSIMA Greene, Leafl. Bot. Crit. **1**: 200. 1906.—This species, termed *Bidens tenerrima* on the labels of the type collection, was originally described by GREENE as "a gigantic ally of *B. connata* but with almost minute heads." And indeed, when the specimens are compared with the true, ternate-leaved *B. connata* Muhl., the difference in the heads is striking. On carefully comparing them, however, with tall slender forms o *B. discoidea* (T. & G.) Britton, I am unable to find any specific difference. GREENE's type, also the severa excellent cotypes in various United States herbaria, should be retained as merely tall, slender forms of *B. discoidea* (T. & G.) Britton.

BIDENS DAHLIOIDES Watson, Proc. Amer. Acad. **26**: 142. 1891.—At times bearing only erostrate achenes and in this respect simulating *Bidens*, to which genus it had already been referred under different names by earlier writers. But from the involucre, the ligules, and the frequently occurring rostrate achenes, it is seen to be a true species of *Cosmos*. As such it was described long before by OTTO, under the name *Cosmos diversifolius*, and one may well conclude that WATSON merely overlooked OTTO's species by mistake.

BIDENS INCISA (J. B. Ker) G. Don.—*Coreopsis incisa* J. B. Ker, Bot. Reg. **1**: 7. 1815; *Bidens incisa* G. Don, Sweet Hort. Brit. ed. 3: 360. 1839; *Bidens reptans* (L.) G. Don, var. *tomentosus* O. E. Schulz, Urb. Symb. Antill. **7**: 141. 1911.

KER very justly separated this species from the smooth-stemmed *B. reptans* (L.) G. Don. He laid too much stress, however, upon the "indented ray" of the latter species, this character varying too much to be of certain value. The recently described *B. reptans tomentosa* O. E. S., based on GEO. E. NICHOLS' no. 137, is merely a slightly smaller-leaved form of *B. incisa* (L.) G. Don, the terminal leaflets being less than "about two inches long." A study of several other collectors' specimens, notably at the New York Botanical Garden, some of which Dr. BRITTON had already labeled *Bidens incisa*, showed

that the terminal leaflet varies in length from about 5 cm. to less than 3 cm. Some of the specimens examined were as follows: *J. H. Hart* (without date); *Geo. E. Nichols* 137, particularly the specimen in the Mo. Bot. Gard. Herb.; *E. G. Britton*, N.Y. Bot. Gard. Explor. Jam. 3867; *N. L. Britton*, same series 73.

Bidens coronata (L.) Britton, auctor emend.—*B. coronata* (L.) Fischer, Britton in Bull. Torr. Bot. Club **20**:281. 1893.

BRITTON, at the time of transferring several American species from *Coreopsis* to *Bidens*, assumed that this species had already been transferred by FISCHER. In fact, as his citation proves, he rested his assumption entirely upon STEUDEL. But a careful examination of STEUDEL (Nomencl. Bot. ed. 2. 1840), with proper regard for his use of italics for synonyms, shows that FISCHER'S plant was *Coreopsis coronata* Hooker (a true *Coreopsis*) and not *Coreopsis coronata* L. STEUDEL even emphasized this fact with the words *nec alior* after *C. coronata* Hooker, to which he referred *Bidens coronata* Fischer. Thus the Linnean species was left in *Coreopsis* until BRITTON'S treatment of it as a species of *Bidens*. That the name may be given a definite and technically correct status, it is here set forth as *Bidens coronata* (L.) Britton.

UNIVERSITY OF CHICAGO

SOME ALASKAN LICHENS

R. HEBER HOWE, JR.

(WITH TWO FIGURES)

During the summer of 1911, the late FRED. B. MCKECHNIE, who accompanied Mr. A. C. BENT on the U.S. National Museum Expedition to Alaska, collected lichens for me in various localities, mostly on the coast of Alaska. The crustose species I sent to Dr. H. E. HASSE of Santa Monica, Cal., for determination, and the species of *Cladonia* and *Stereocaulon* were kindly named by Dr. L. W. RIDDLE of Wellesley, Mass. I have arranged the species in accord with Miss CLARA E. CUMMINGS' *Lichens of Alaska* (1910) for convenience in comparison, as well as with my Yukon list.[1] MR. MERRILL'S Yukon lichens[2] should not be overlooked among the recent papers on boreal northwest species.

SPHAEROPHORIACEAE

1. SPHAEROPHORUS (CORALLOIDES) GLOBIFERUS (L.) DC.—Ketchikan, May 27, 1911; Little Kiska Is., June 19, 1911, "1000–1500 ft."; Unalaska Is., Chernofski, June 10, 1911.

LECIDIACEAE

2. BAEOMYCES (AERUGINOSUS) ERICETORUM (L.) Wain.—Ketchikan, May 27, 1911, "rotten stump."

CLADONIACEAE

3. CLADONIA RANGIFERINA (L.) Web.—Little Kiska, June 19, 1911, tundra, 1000–1500 ft.; Atka, June 27, 1911, grass, 1500 ft.

4. CLADONIA SYLVATICA (L.) Hoffm.—Little Kiska, June 19, 1911, tundra 1000–1500 ft.; Atka, June 27, 1911, grass, 1500 ft.

5. CLADONIA UNCIALIS (L.) Web.—Amaknak Is., June 6, 1911, moss, 1200 ft.; Nome, July 14, 1911.

6. CLADONIA COCCIFERA (L.) Willd.—Nome, July 13, 1911, meadows.

[1] Bull. Torr. Bot. Club **38**:287–293. 1912.

[2] Bryologist **11**:105–111. 1908.

7. CLADONIA CORNUTA (L.) Schaer.—Atka, June 27, 1911, 1500 ft.

8. CLADONIA DECORTICATA (Flk.) Spreng.—Atka, June 27, 1911, 1500 ft.

9. STEREOCAULON TOMENTOSUM Fr.—Unalaska Is., Chernofski, June 9, 1911, tundra, 150 ft.

10. STEREOCAULON PASCHALE (L.) Ach.—Atka Is., June 22, 1911, tundra, 1000 ft.

LECANORIACEAE

11. LECANORA OCCULATA (Dicks.) Ach.—Little Kiska, June 19, 1911; Atka, June 26, 1911.

12. LECANORA SAXATILIS (L.) Schaer (*L. muralis*).—St. Paul Is., June 1911; three specimens.

13. LECANORA CASTANEA (Hepp.) Th. Fr.—Amaknak Is., June 6, 1911, 1200 ft.

14. LECANORA CARTILAGINEA Ach.—St. Paul Is., June 1911.

15. OCHROLECHIA GEMINIPARA Th. Fr.—Nome, July 14, 1911.

16. OCHROLECHIA UPSALIENSIS Nyl.—Nome, July 4, 1911.

17. CALOPLACA CALOPISMA (Ach.) Th. Fr.—Chernofski, June 10, 1911.

PELTIGERIACEAE

18. PELTIGERA CANINA (L.) Hoffm.—Amaknak Is., Little Kiska Is., June 19, 1911, "tundra, 1000–1500 ft."; June 6, 1911, 1000 ft., "growing on ground just above and below snow line"; Akun Is., June 4, 1911, "dead logs"; Atka Is., June 13, 1911, "tundra"; four specimens, three of which represent the variety *spongiosa* Tuck.

19. NEPHROMA ARCTICUM (L.) Fr.—Nome, June 14, 1911.

20. **Lobaria** (STICTA) **oregana** (Tuck.), comb. nov.—Ketchikan, May 26, 27, 1911, "thick fir growth."

UMBILICARIACEAE

21. GYROPHORA (UMBILICARIA) ARCTICA Ach.—Atka Is., June 27, 1911, "rocks, 1000 ft., snow near by"; two specimens.

PARMELIACEAE

22. PARMELIA SAXATILIS Ach.—Unalaska Is., Chernofski, June 9, 1911, "on rocks along the beach," two specimens; St. Paul Is., July 6, 1911, "rocks near beach," one specimen.

23. PARMELIA SAXATILIS Ach. var. SULCATA (Tayl.) Nyl.—Akun Is., June 4, 1911, "on logs."

24. ———, var. OMPHALODES (L.) Fr.—Atka Is., June 27, 1911, "2000 ft. on rocks"; St. Paul Is., July 7, 1911.

25. ———, var. FURFURACEA Schaer.—St. Paul Is., July 6, 1911, "on rocks." All these specimens show the dicroic reddish margins mentioned by MACOUN and Miss CUMMINGS.

26. XANTHORINA (TELOSCHISTES) LYCHNEA (Ach.) Th. Fr.—The material represents according to Dr. HASSE the variety *lacinosa* Schaer, but like material was referred to the variety *pygmaea* (Fr.) Th. Fr. by Miss CUMMINGS, St. Paul Is., July 6, 1911, "on rocks."

FIG. 1.—The Bellardi-type of *Lichen cuculata* preserved at Turin

USNEACEAE

27. ALECTONIA OCHROLEUCA var. CINCINNATA (Fr.) Nyl.—Unalaska, Chernofski, June 11, 1911, "200 ft."

28. COELOCAULON (ALECTORIA) DIVERGENS (Ach.) Howe.—Little Kiska Is., June 19, 1911, "tundra, 1000–1500 ft."

29. PLATYSMA (CETRARIA) LACUNOSUM (Ach.) Nyl.—Atka Is., June 26, 1911; Ketchikan, May 26–27, 1911, "on fir limb twigs"; Little Kiska Is., June 19, 1911, "1000–1500 ft., tundra." These specimens represent the true *lacunosum* of ACHARIUS (type loc. "America boreali"). Mr. MERRILL renamed the typical form

("rugoso-reticulato celluloso albo subvirescente" Ach.) when he (Bryol. **13**:26. 1910) made the forma *cavernosa* (Menzies) Merr. (reticulate-lacunose-cellulose"—"whitish-cinereous" Merr.). The less lacunose virescent examples with perforate apothecia, common in the eastern states, were named by TUCKERMAN as the variety

FIG. 2.—The Linnean type of *Lichen nivalis* preserved at London

atlantica (Tuck.) Nyl. It is, in view of the true type, a well marked variety, which has been lost sight of lately. *Platysma glaucum* (L.) Nyl. is *never lacunose-reticulate* above, *always nitidous below*, and the margins are always crisped.

30. PLATYSMA (CETRARIA) GLAUCUM var. **stenophyllum** (Tuck.), comb. nov.—Ketchikan, May 27, 1911. The margins of

this variety are always *dissected*, never *entire* as in var. *stenophyllum* of the preceding species.

31. CETRARIA CUCULLATA (Bell.) Ach.—Amaknak Is., June 6, 1911.

32. CETRARIA NIVALIS (L.) Ach.—Amaknak Is., June 6, 1911. The plate of the types of the above two species it is thought of value to publish. Dr. WAINIO failed to record the *nivalis* type as represented in the Linnean herbarium. Through the kindness of Dr. B. DAYDON JACKSON of the Linnean Society, I was enabled to photograph it, as also the Bellardi type preserved at Turin in the R. Istituto Botanico through the kindness of Dr. O. MATTIROLO.

33. DACTYLINA MADREPORIFORMIS (Wolf.) Ach.—Little Kiska Is., June 19, 1911, "1000–1500 ft., tundra."

34. RAMALINA SUBFARINACEA Nyl. (*R. angustissima* [Anzi.] Wain., a nomen nudum).—St. Paul Is., June 6, 1911, "rocks near beach," Atka Is., June 13, 1911, "tundra." These specimens represent evidently the same material mentioned under *Ramalina cuspidata* Nyl. (KOH−) and *Ramalina javanica* Nyl. by Mr. MERRILL (Bryol. **11**:51. 1908). The plants are referable to *Ramalina calicaris* (L.) Fr. emend. (*R. scopulorum* [Retz.] Ach.)[3] except for their subterete lacinia, and more or less multifid, sorediate tips (KOH+). The smaller examples suggest a little *Ramalina intermedia* Nyl. (KOH−).

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[3] See Bryol. **16**: Nov. 1913.

BRIEFER ARTICLES

INCLUDED CYTOPLASM IN FERTILIZATION

In the recent review[1] of NĚMEC's paper on the fertilization of *Gagea lutea*,[2] the following statements occur: "Another apparently unusual feature is the inclusion of cytoplasm between the fusing nuclei. . . . . This is the second record of such a cytoplasmic inclusion, the first having been made by BROWN[3] in his study of *Peperomia*."

Since this is a rarely recorded phenomenon, I may be permitted to call attention to some earlier references to the inclusion of cytoplasm between the sexual nuclei in plants at the time of fusion. In a paper published in 1901,[4] the following sentence occurs (p. 450): "Frequently the cytoplasm caught between the two nuclei collects in spherical masses; between these spheres of cytoplasm the membranes of the nuclei come into close contact (fig. 52)." This sentence is likewise repeated on p. 116 of a later publication.[5] I would also call attention to figs. 51, 53, and 54 of the earlier paper, and figs. 224–227 of the later paper, which were redrawn from the same preparations as the figures published earlier.

BROWN first figured and described the inclusion of cytoplasm between the fusion nuclei in 1908.[6] If other students of plants have mentioned this subject, I am not aware of it.

In the papers published in 1901 and 1904, I made no special comment, other than the sentence quoted above, on the inclusion of cytoplasm between the sexual nuclei, because this is one of many observations which have convinced me that nucleus and cytoplasm cooperate in all cell

[1] CHAMBERLAIN, CHARLES J., Fertilization in *Gagea*. BOT. GAZ. **55**:472. 1913.

[2] NĚMEC, B., Über die Befruchtung bei *Gagea*. Bull. Internat. Acad. Sci. Bohême 1912: 1–17. *figs. 19*.

[3] BROWN, W. H., The exchange of material between nucleus and cytoplasm in *Peperomia sintenisii*. BOT. GAZ. **49**:189–194. *pl. 13*. 1910.

[4] FERGUSON, MARGARET C., The development of the egg and fertilization in *Pinus Strobus*. Ann. Botany **15**:435–479. *pls. 23–25*. 1901.

[5] ———, Life history of *Pinus*. Proc. Wash. Acad. Sci. **6**:1–202. *pls. 1–24*. 1904.

[6] BROWN, W. H., The nature of the embryo sac of *Peperomia*. BOT. GAZ. **46**: 445–458. 1908.

divisions, whether in somatic or in reproductive cells. In the description of the division of the generative cell in *Pinus*,[7] this sentence appears (p. 209): "That the spindle-fibers which originate in the cytoplasm and apparently grow by a differentiation of its network are later fed by the linin of the achromatic nuclear reticulum there seems little room for doubt. In fact, all the phenomena connected with this division indicate that we are dealing, not with persistent cell-constituents, but with different manifestations of one and the same thing." With variations in method of expression, this idea is promulgated again and again in the three papers on *Pinus* to which reference has already been made.

It is interesting to find such convincing evidence of the transformation of cytoplasm to nucleoplasm, or at least, of its disappearance in the nucleoplasm, as that given by BROWN. The close student of the phenomena of fecundation and of nuclear division finds, also, many evidences, less clearly demonstrable but equally convincing, of the intimate relation between these two portions of the protoplasm.

There can be no doubt that threads from the cytoplasm unite with portions of the nuclear reticulum to form the spindle-fibers in the division of the generative cell in *Pinus;* and it is equally evident, at the time of fertilization, not only that the "included cytoplasm" disappears in the area occupied by the conjugating nuclei, but that a large part of the reticulum of the egg nucleus disappears in the general cytoplasm. These and similar unpublished observations on other plants convince me that certain portions, at least, of cytoplasm and nucleus are interchangeable.—MARGARET C. FERGUSON, *Wellesley College*.

HENRY WILLEY

(WITH PORTRAIT)

The work of HENRY WILLEY in lichenology entitles him to a more definite introduction among botanists than he has received. He was born in Geneseo, N.Y., July 10, 1824, and died in South Weymouth, Mass., March 15, 1907. During his active life he was the editor of a newspaper in New Bedford Mass., resigning that position in 1900. As a student of lichens, he probably ranked second only to TUCKERMAN, whose pupil he was, and whose last work he edited. His various contributions to the literature of lichens appeared during the period from 1867

[7] FERGUSON, MARGARET C., The development of the pollen tube and the division of the generative nucleus in certain species of pines. Ann. Botany **15**:193–223. *pls. 12–14*. 1901.

to 1892, and then he disappeared from botanical literature during the last fifteen years of his life.

As a man, he was very eccentric, being exceedingly diffident and having only the one great interest. For the most part he lived alone in complete seclusion, with his library and herbarium as his only companions. The herbarium was purchased for the National Herbarium after his death, so that the permanent record of his work has been made available for all subsequent students of lichens. Although a recluse socially, he was very generous in his work for others, determining cheerfully hundreds of specimens of lichens that were sent to him, but brusquely resenting any apparent effort to impose upon him.

The inner flavor of the man may be obtained by the following tribute he paid to TUCKERMAN:

> And here I would pay a last tribute to the memory of one to whom, for the unbounded liberality of the information imparted from 1862 to the time of his death, and for his patience under my sometimes too great demands upon him, I am under such great obligations. EDWARD TUCKERMAN was surpassed by none of the botanists of his day in his disinterested love of truth, in the patience with which he sought to unravel the difficulties of the most difficult of all plants, and in the philosophic spirit with which he labored to trace affinities and to bring them into natural connection.

A very interesting account of HENRY WILLEY, from which the above information was obtained, was published in the *New Bedford Standard* of July 20, 1913, prepared by R. HEBER HOWE, JR.—J. M. C.

CURRENT LITERATURE

NOTES FOR STUDENTS

Metabolism of fungi.—Among recent papers on the metabolism of fungi two on protein synthesis are of special interest. The first by EHRLICH[1] relates to the utilization of the nitrogen of amino acids when substances other than sugar form the source of energy. In his former work EHRLICH showed that in the presence of sugar the α-amido acids are transformed by yeast into carbon dioxide, ammonia, and alcohols with one carbon atom fewer than the corresponding amino acids, the ammonia being used in protein synthesis, while the carbon residue is excreted as a waste product. In the present paper he reports the results of an investigation of the action of yeasts on an amino acid, tyrosin, when simpler compounds such as alcohol, glycerine, lactic acid, etc., are supplied as sources of carbon. He finds that the decomposition of the amino acid proceeds in the same manner regardless of the source of carbon, and that even with these less favorable sources of energy the nitrogenous radical only of the amino acid is utilized by the organism. In cultures containing cane sugar, glycerine, or alcohol in addition to tyrosin, small quantities of esters and volatile fatty acids were formed. *Oidium lactis* was found to behave in an analogous manner. EHRLICH and JACOBSON had shown that in the presence of sugar this fungus produces from amino acids the corresponding oxyacids. Its behavior in this respect was not changed when glycerine, lactic acid, or alcohol were used instead of sugar. With each of these substances tyrosin yielded paraoxyphenyl lactic acid, only the nitrogenous portion of the molecule being utilized by the fungus.

PURIEWITSCH[2] approached the problem of protein synthesis from another point of view, by determining the energy required, as measured by the carbon dioxide output per unit of dry weight of fungus, for the assimilation of different nitrogenous compounds by *Aspergillus niger*. Of the large number of nitrogenous compounds tested with sugar, low ratios of carbon dioxide to dry weight were obtained with methyl urea, the amino acids, potassium sulphocyanate, acetamide methyl amine, and urea, while such compounds as guanidin, ethylamine, potassium nitrate, peptone, protein, and phenyl urea gave higher ratios, showing that more energy is required for their assimilation. Fewer nitrogenous compounds were tried in connection with succinic acid, malic acid,

[1] EHRLICH, F., Über die Bildung des Plasmaeiweisses bei Hefen und Schimmelpilzen. Biochem. Zeitschr. **36**:477–497. 1911.

[2] PURIEWITSCH, K., Untersuchungen über die Eiweisssynthese bei niederen Pflanzen. Biochem. Zeitschr. **38**:1–13. 1912.

or tartaric acid in place of sugar. The ratios for these acids were higher than those obtained with sugar, and they increased for the different acids in the order in which the acids are named. The general arrangement of the nitrogenous compounds in the order of their assimilability was essentially the same for these acids as for sugar.

As a result of his experiments, PURIEWITSCH favors the view of CZAPEK, according to which the α-amino acids serve directly as materials for protein synthesis. He has overlooked, however, much of the recent work of EHRLICH and others who have shown conclusively, for yeasts and *Oidium lactis* at least, that it is only the amido group in the form of ammonia that is used for protein synthesis, while the rest of the molecule is entirely rejected. The author, therefore, is in error when he states that there is no evidence that the ammonia split off from organic compounds serves as a source of material for protein synthesis.

A further contribution to the subject of nitrogen metabolism of fungi has been made by EHRLICH and PISTSCHIMUKA,[3] in their study of the fermentation of the primary amines. They find that with yeasts, especially *Willia anomala* and wild yeasts, and *Oidium lactis*, these substances undergo a fermentation, resulting, like the analogous fermentation of amino acids, in the production of the higher alcohols. The process results in a substitution of the amido group by the hydroxy group according to the following general reaction:

$$R \cdot CH_2 \cdot NH_2 \xrightarrow[-NH_3]{+H_2O} R \cdot CH_2OH$$

By this process tyrosol was obtained from p-oxyphenylethylamine and fusil oil from isoamylamine. As in the case of the amino acids, only the nitrogenous part of the molecule is utilized by the organisms, the rest of the molecule being transformed into the corresponding alcohol.

The easy fermentation of amines to the corresponding alcohols raises the question whether the transformation of amino acids to alcohols does not take place with the intermediate formation of amines rather as NEUBAUER and FROMHERZ[4] believe, than with the intermediate formation of keto-acids.

In continuation of his studies on nitrogen metabolism, EHRLICH[5] reports a further example of the fermentation of an amino acid with the production of the corresponding alcohol. He obtained tryptophol (β-indolylethyl alcohol) by the action of yeast on trytophan (β-indolyl alanin). The chemical properties of the new compound are described in detail.

The influence of nutrition on the secretion of enzymes by fungi, a problem concerning which different investigators have arrived at different conclusions,

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[3] EHRLICH, F., und PISTSCHIMUKA, P., Überführung von Aminen in Alkohole durch Hefe- und Schimmelpilze. Ber. Deutsch. Chem. Gesells. **45**:1006–1012. 1912.

[4] Rev. BOT. GAZ. **54**:343. 1912.

[5] EHRLICH, F., Über Tryptophol (β-indolylethyl Alcohol) ein neues Gärprodukt der Hefe aus Aminosäuren. Ber. Deutsch. Chem. Gesells. **45**:883–889. 1912.

has been investigated by GREZES[6] with respect to the production of invertase and other enzymes by *Aspergillus niger;* and by KNUDSON with respect to the production of tannase by *Aspergillus niger*, *Penicillium rugulosum*, and an unknown species of *Penicillium*.

GREZES finds that *Aspergillus niger*, even when grown on RAULIN's solution containing no sugar and with succinic acid as the sole source of carbon, produces invertase, diastase, maltase, inulase, and emulsin. A quantitative study of the production of invertase by the fungus on media containing, on the one hand cane sugar and on the other succinic acid, a substance not related to the carbohydrate group, showed that the production of the enzyme is greatly influenced by the mode of nutrition. Only small quantities of invertase are produced by cultures on succinic acid, yet its production is not entirely suppressed, even after 60 spore-generations on succinic acid, and nearly normal production immediately takes place if the fungus is transferred to sugar solutions. The author concludes that the power of invertase production is an inseparable characteristic of the fungus.

KNUDSON[7] finds that tannase is not produced by *Aspergillus niger* nor by the species of *Penicillium* which he studied if there is no tannic acid or its decomposition product, gallic acid, in the solution. If either of these substances is present there is a progressive increase in the production of tannase with increase of concentration of the acids. With a constant concentration of tannic acid the production of the enzyme is depressed with increasing concentration of sugar. Mycelia grown on various organic compounds other than gallic acid contain no tannase. Gallic acid stimulates the production of tannase even in solutions containing 10 per cent of cane sugar.

A number of papers deal with the hydrolysis by fungi of glucosides, tannin, and other less complex compounds. UHLENHAUT[8] studied the hydrolysis of amygdalin by the action of fungi, but, aside from extending somewhat the list of fungi capable of splitting amygdalin, his paper adds nothing essential to that which is already known concerning the process. The 14 species which he investigated differed considerably, as judged by purely qualitative tests, in their capacity for hydrolyzing the glucoside. The mucors were in general found to be more active in this respect than the higher fungi. The growth of the mucors on amygdalin solutions was usually soon inhibited, owing to the accumulation of benzene cyanhydrin, to which the author ascribes the hydrocyanic acid odor developed in the cultures. If, however, other fungi capable of utilizing the excess of cyanhydrin are grown in cultures together with mucors,

[6] GREZES, G., Recherches sur la sucrase de l'*Aspergillus niger*. Ann. Inst. Pasteur **26**: 556–573. 1912.

[7] KNUDSON, L., Tannic acid fermentation. II. Effect of nutrition on the production of the enzyme tannase. Jour. Biol. Chem. **14**: 185–202. 1913.

[8] UHLENHAUT, H., Über die Spaltung des Amygdalins durch Schimmelpilze. Ann. Mycol. **9**: 567–621. 1911.

the mucors flourish better than in pure cultures. With other sources of carbon present amygdalin is more or less protected from the action of fungi. The influence of other factors, such as light, metal salts, and osmotic pressure on the hydrolysis of amygdalin by fungi is also considered. Quantitative data are entirely absent from the paper.

In a short paper HÉRISSEY and LEBAS[9] report that aucubine, the glucoside of *Aucuba Japonica*, is hydrolyzed by *Aspergillus niger* in acid solution and more slowly in neutral solution. Fuller details as to the mode of hydrolysis are lacking.

KNUDSON[10] reports the results of a series of investigations on the hydrolysis of tannic acid by fungi. He finds that the substance is generally toxic in concentrations of 2–5 per cent. Of 23 species of fungi, representing mucors, ascomycetes, and basidiomycetes, only 3, *Aspergillus niger*, *A. flavus*, and a species of *Penicillium*, made good growth, on a 10 per cent solution. *Aspergillus niger* was originally described from material growing on tannic acid solution by VAN TIEGHEM, who first observed that this organism and a species of *Penicillium* ("*P. glaucum*") brought about the hydrolysis of tannin with the formation of gallic acid. KNUDSON studied the action of *Aspergillus niger* and a species of *Penicillium* probably different from that of VAN TIEGHEM, and finds that the *Aspergillus* is the more active in bringing about the hydrolysis of tannic acid. A part of the gallic acid formed is consumed by the fungi. The extent to which the acid is consumed depends on the presence of other more favorable food substances. In a synthetic culture solution containing tannic acid the gallic acid is consumed to a greater extent than in gall-nut infusions which contain other food substances. In a 10 per cent sugar solution the gallic acid is left intact. The hydrolysis takes place also under anaerobic conditions, and under both aerobic and anaerobic conditions a part of the enzyme diffuses into the culture medium.

Statements by PRINGSHEIM and ZEMPLÈN that certain fungi (*Rhizopus tonkinensis*, *Mucor javanicus*, *Penicillium purpurogenum*, *P. africanum*, and *P. brevicaule*) not possessing invertase are capable of utilizing cane sugar have led RITTER to reinvestigate the behavior of a number of fungi in relation to their capacity for utilizing that sugar. His results are in accord with the general proposition that in fungi, as well as in higher plants and in animals, cane sugar is not capable of direct assimilation, but can be utilized only by those organisms producing invertase. Among the fungi which RITTER[11] tested, *Mucor spinosus*, *M. javanicus*, *Thammidium elegans*, *Rhizopus nigricans*, and *R. tonkinensis*

[9] HÉRISSEY, H., et LEBAS, C., Utilization de l'aucubine par l'*Aspergillus niger* v. Tgh. Compt. Rend. Soc. Biol. Paris **70**:846–848. 1911.

[10] KNUDSON, L., Tannic acid fermentation I. Jour. Biol. Chem. **24**:159–184. 1913.

[11] RITTER, G. E., Über das Verhältnis der Schimmelpilze zum Rohrzuoker. Biochem. Zeitschr. **42**:1–6. 1912.

made practically no growth on nutrient solutions containing cane sugar with potassium nitrate or ammonium tartrate as sources of nitrogen. *Penicillium purpurogenum*, which grew well on cane sugar, was found to contain invertase, contrary to the statement of PRINGSHEIM and ZEMPLÈN.

JEGOROFF,[12] studying the assimilability of phytin by mold fungi (*Aspergillus niger* and *Penicillium* sp.), confirms the results of DOX, according to which that substance is hydrolyzed by the action of molds, the phosphorous radicle being utilized as a source of phosphorus by the fungi. Sterilization of nutrient solutions containing phytin does not in itself cause hydrolysis of the substance. In cultures containing peptone and cane sugar inorganic phosphorus (potassium dihydrogen phosphate) gave a better yield than phytin, but in cultures containing only cane sugar or only glycerine as sources of carbon, phytin gave better yields than inorganic phosphorus. Peptone gave low yields with both phytin and potassium dihydrogen phosphate, the culture showing little difference in favor of either.

The work of a number of investigators has shown that urea, uric acid, hippuric acid, and glycocoll serve not only as sources of carbon and nitrogen for fungi, but also as sources of nitrogen for green plants. The availability of these compounds as nutrients for fungi has been further investigated by KOSSOWICZ[13] with reference to the following fungi: *Botrytis Bassiana*, *Penicillium crustaceum*, *P. brevicaule*, *Mucor Boidin*, *Cladosporium herbarum*, *Phytophthora infestans*, *Aspergillus glaucus*, *A. niger*, *Isaria farinosa*, and a species of *Fusisporium*. He finds that in cultures with cane sugar all the fungi made good growth in solutions containing urea or uric acid; *Cladosporium herbarum* failed to grow on solutions containing glycocoll; and *Penicillium crustaceum*, *P. brevicaule*, *Aspergillus glaucus*, and *Cladosporium herbarum* failed to grow on hippuric acid. In later experiments, however, in which dextrose or mannite were substituted for cane sugar, and the culture solution was somewhat modified as to its inorganic constituents, these four species also were able to utilize all of the compounds in question. The cause of this peculiar difference of behavior is not discussed. Some of these compounds served as sources of both carbon and nitrogen for certain of the fungi. Uric acid served thus for *Aspergillus glaucus*, *Isaria farinosa*, *Penicillium glaucum*, *Mucor Boidin*, *Phytophthora infestans*, and *Botrytis Bassiana;* hippuric acid for *P. glaucum*, *A. niger*, *A. glaucus*, *I. farinosa*, *B. Bassiana*, *Ph. infestans*, *Cladosporium herbarum*, and *Fusisporium;* and glycocoll for *P. glaucum*, *C. herbarum*, *B. Bassiana*, *I. farinosa*, *Ph. infestans*, *A. niger*, *A. glaucus*, and *M. Boidin*.

[12] JEGOROFF, M. A., Über das Verhalten von Schimmelpilzen (*Aspergillus niger* und *Penicillium crustaceum*) zum Phytin. Zeitschr. Physiol. Chem. **82**:231–242. 1912.

[13] KOSSOWICZ, A., Die Zersetzung von Harnstoff, Harnsäure, Hippursäure, und Glykokoll durch Schimmelpilze. Zeitschr. Gärungsphysiol. **1**:60–62. 1912; also **2**:51–54. 1912.

In connection with these experiments KOSSOWICZ[14] has examined the action of the extracts of six of the species of fungi on uric acid and on hippuric acid. He confirms the results of earlier investigators who have shown that the fermentation of hippuric acid is an enzymatic process, and shows also that the decomposition of uric acid by fungi is a process of similar nature. Extracts of *Aspergillus niger*, *Mucor Boidin*, *Phytophthora infestans*, *Isaria farinosa*, and *Botrytis Bassiana* were found to ferment both acids, while extracts of *Cladosporium herbarum* acted only on uric acid.

The acceptance of the liberation of ammonia as a criterion of the fermentation of hippuric acid has been criticized by DOX and NEIDIG,[15] who find as a result of quantitative determinations of the glycocoll produced in the process that ammonia is formed only in small quantities as a result of secondary decomposition of glycocoll.

The mode of absorption and utilization of fats by fungi has been investigated by SPIECKERMANN.[16] By means of cultures on infusorial earth, from which the residual acids could be extracted, he was able to show that the higher fatty acids in the form of their salts (soaps, especially the calcium and the ammonium soaps whose decomposition does not result in the accumulation of strong alkali in the cultures) are utilized to a large extent. The somewhat contrary results of SCHMIDT are to be ascribed to his use of alkali soaps whose decomposition caused too great a degree of alkalinity of the culture medium. In cultures on agar plates in which sodium nitrate was present and in which the free fatty acids were distributed in a finely divided state throughout the agar, a broad clear zone, indicating the formation of soap by the action of the alkali set free by the utilization of the nitrate group, appeared around the colonies. When ammonium sulphate was used instead of sodium nitrate a narrower zone appeared about the colonies, showing that even in the acid medium an extracellular solution of the fatty acids takes place, although the process here is not as readily explained as in the first case. Similar phenomena observed with reference to fats show that they also undergo extracellular solution before being absorbed by living cells. From these observations the author concludes that fats are taken into the cell in the form of soaps or as free fatty acids.

As a result of an examination of a large number of yeasts and other budding fungi, as well as a number of filamentous forms found in connection with the industries dependent on fermentation, LINDNER and CZISER[17] find that the

[14] KOSSOWICZ, A., Die enzymatische Natur der Harnsäure- und Hippursäure-Gärung. Zeitschr. Gärungsphysiol. **1**:121–123. 1912; also **1**:317–319. 1912.

[15] DOX, A. W., and NEIDIG, R. E., Enzymatische Spaltung von Hippursäure durch Schimmelpilze. Zeitschr. Physiol. Chem. **85**:68–71. 1913.

[16] SPIECKERMANN, A., Die Zersetzung der Fette durch höhere Pilze. I. Der Abbau des Glycerins und die Aufnahme der Fette in die Pilzzelle. Zeitschr. Unters. Nahrungs- und Genussmittel. **23**:305–331. *pls. 3*. 1912.

[17] LINDNER, P., und CZISER, S., Der Alkohol, ein mehr oder weniger ausgezeichneter Nährstoff für verschiedene Pilze. Wochenschr. Brauerei **29**:1–6. 1912.

ability to assimilate alcohol, although varying with different races, is almost universal among these organisms. The loss thus sustained in the process of fermentation they suggest should be taken into consideration in devising methods of operation.

Similarly, in a short note WILL and HEUSS[18] show that, as is well known for other fungi, various budding forms, including species of *Mycoderma*, *Torula*, *Willia*, and *Pichia*, consume ethyl acetate, apparently utilizing both the acid and the alcohol radicle in their metabolism.

The study of the production of toxic substances by fungi growing on food products destined for human consumption has recently attracted much attention, especially in Italy in connection with the investigation of pellagra. From this point of view ALSBERG and BLACK[19] have investigated substances elaborated by two species of molds; the one, *Penicillium puberulum* Bainier, isolated from spoiled maize in Nebraska, and the other, *P. stoloniferum* from similar material from Italy. From the culture medium (RAULIN'S solution) in which *P. puberulum* was grown, the authors isolated a substance to which the name penicillic acid, with the formula $C_8H_{10}O_4$, was given. The substance, which behaves like a monobasic acid, is fatal to animals when injected subcutaneously in doses of 0.2–0.3 grams per kilogram of body weight. It is formed more abundantly when the air supply of the fungus is limited than with full aeration. An acid medium also favors its production.

Penicillium stoloniferum elaborates a non-toxic substance to which the name mycophenolic acid is given. Its empirical formula is $C_{17}H_{20}O_6$. It behaves like a dibasic acid and resembles the lichen acids in many ways. With ferric chloride this substance gives the violet color of GOSIO'S phenol reaction, which in Italy is regarded as a reliable test for the detection of deterioration in maize, but which the authors were unable to obtain in its characteristic form from samples of spoiled American maize.

In conclusion, the authors point out the desirability of utilizing biochemical behavior as an aid in the separation of species of molds which are not easily distinguished by morphological characteristics.

Owing to the ability of some molds to complete their development with traces of certain universal elements so minute that they cannot be removed by chemical means, the study of the influence of such elements on spore-production presents difficulties which account for the variant results obtained by different and sometimes by the same investigators. Formerly SAUTON[20] ascribed to iron a special rôle in the spore-production of *Aspergillus niger*, but later he and

[18] WILL, H., und HEUSS, R., Essigsäureäthylester als Kohlenstoffquelle für Hefe und andere Sprosspilze. Zeitschr. Gesamte Brauwesen. **35**: 128–129. 1912.

[19] ALSBERG, C. L., and BLACK, O. F., Contributions to the study of maize deterioration. U.S. Dept. Agric., Bur. Plant Ind. Bull. 270. pp. 48. *pl. 1*. 1913.

[20] Rev. BOT. GAZ. **55**: 86. 1913.

JAVILLIER[21] negatived this conclusion and attributed the lack of spore-formation in the absence of iron to the deleterious effect of zinc in RAULIN'S solution, for they found that when both zinc and iron were absent spores were produced by the fungus. Meanwhile, BERTRAND[22] reported experiments which seemed to indicate that manganese played a special part in the spore-production of *Aspergillus niger*.

The question of the influence of various elements on the spore-production of molds has now been further investigated by SAUTON.[23] He finds that if *A. niger* is grown on RAULIN'S solution to which iron in the form of ferric ammonium citrate has been added, no spores are produced, thus strengthening his conclusion that iron plays no special part in the spore-production of that fungus. If, however, iron sulphate is added to the solution, spores are produced. The difference in behavior of the two salts may be ascribed to the absence of manganese in the one and its presence in the other. The author finds, however, that in a solution without zinc, spores are produced in the absence of any detectable traces of iron and manganese, and concludes, therefore, that if these elements are necessary for *A. niger*, the requisite quantities are limited to such minute traces that they cannot be detected chemically. He finds that in this respect *A. fumigatus* is a more favorable object of experimentation. If of the two elements in question manganese alone is present in the culture solution, this fungus produces spores after 15 days, while with iron also present spores are produced on the third day. If manganese is absent no spores are formed. It appears, therefore, that for this mold both iron and manganese are necessary for spore-production. The influence of some of the other elements of RAULIN'S solution on spore-production was also determined. In the absence of sulphur *A. niger* grows poorly but nevertheless produces spores. *A. fumigatus*, however, does not produce spores in the absence of that element. No spores are produced by either mold in the absence of potassium, but the addition or withdrawal of caesium and rubidium are without influence. In the absence of phosphorus no spores are formed, but it does not seem to be possible to exclude magnesium to such an extent as to inhibit spore-formation.

It is likely that this work would lead to more definite results if it were separated from the problem of the toxicity of zinc, which although placed by RAULIN among the elements of his culture solution is not a substance necessary in the metabolism of plants.

BERTRAND and JAVILLIER[24] have republished their experiments on the action

[21] Rev. Bot. Gaz. **55**: 88. 1913.

[22] Rev. Bot. Gaz. **55**: 89. 1913.

[23] SAUTON, B., Sur la sporulation de l'*Aspergillus niger* et de l'*Aspergillus fumigatus*. Ann. Inst. Pasteur **27**: 328–335. 1913.

[24] BERTRAND, Dr., et JAVILLIER, M., Action combiné du manganèse et du zinc sur le développment et la composition minérale de l'*Aspergillus niger*. Ann. Inst. Pasteur **26**: 515–521. 1912.

of zinc and manganese, the first publication of which has been reviewed in this journal.[25]

From recent work of RITTER[26] and of HAGEM,[27] as well as from scattered observations in the older literature, it appears that the power of using nitrogen in the form of nitrite is widespread among filamentous fungi. A further contribution to this subject is made by KOSSOWICZ,[28] who finds that *Botrytis Bassiana*, *Penicillium glaucum*, *P. brevicaule*, *Mucor Boidin*, *Cladosporum herbarum*, *Phytophthora infestans*, *Aspergillus glaucus*, *A. niger*, *Isaria farinosa*, and a species of *Fusisporium* grow readily on synthetic culture solutions containing potassium as the sole source of nitrogen; and cane sugar, dextrose, or mannite as carbon compounds. The formation of ammonia could be definitely shown to occur only in mannite cultures of *Phytophthora infestans* and in those of *Fusisporium*. In cultures containing sugars the ammonia reaction of Nessler's reagent is not reliable on account of the similar reaction given by dextrose. It is erroneous, however, to conclude from the absence of the ammonia test that nitrites are not reduced to ammonia before being assimilated. The absence of ammonia merely shows that it is not produced in excess of the quantity used. In the absence of quantitative data showing the yields produced, the effect of nitrogenous substances in the tap water which the author used in his experiments cannot be easily estimated.

KOSSOWICZ and GRÖLLER[29] have investigated the value of sulphocyanates as sources of nitrogen, carbon, and sulphur for fungi. The same species of molds mentioned in the paper reviewed above were used in the experiments. It was found that in the absence of other nitrogenous compounds (except such as were introduced by means of the tap water and as impurities in the other compounds used) the fungi made a feeble growth which soon ceased in nutrient solutions containing ammonium, potassium, sodium, or iron salts of sulphocyanic acid. Traces of hydrogen sulphide were detected only in cultures of *Mucor Boidin* and occasionally in those of *Aspergillus niger* and *A. glaucus*. The conclusion that the fungi used in these experiments can obtain nitrogen from sulphocyanates would seem to need further support in view of the fact that in all cases there was a cessation of growth after a few days. The fungi made no growth when sulphocyanates were the sole source of carbon or of both carbon and nitrogen. A feeble growth appeared when the substance was the sole source of sulphur. Sulphocyanates seem to be only slightly toxic, although they cause a distinct depression of growth, yet even in a 10 per cent

[25] BOT. GAZ. **55**:89. 1913.

[26] Rev. BOT. GAZ. **55**:91. 1913.

[27] Rev. BOT. GAZ. **55**:463. 1913.

[28] KOSSOWICZ, A., Nitritassimilation durch Schimmelpilze. Zeitschr. Gärungsphysiol. **2**:55–58. 1912.

[29] KOSSOWICZ, A., und GRÖLLER, L. VON, Rhodanverbindungen (Schwefelcyanverbindungen) als Kohlenstoff, Stickstoff, und Schwefelquelle für Schimmelpilze, Sprosspilze (Hefen), und Bakterien. Zeitschr. Gärungsphysiol. **2**:59–65. 1913.

solution growth is not entirely inhibited. The non-toxicity of sulphocyanates has also been observed by FERNBACH and in extremely dilute solutions by SAUTON.[30]

In a short note KOSSOWICZ and LOEW[31] report the availability of sodium thiosulphate as a nutrient for a number of yeasts and fungi. Hydrogen sulphide, free sulphur, and sulphuric acid are among the products resulting from the action of different organisms on the compound.—H. HASSELBRING.

The leaf-bud of Cordaites.—LIGNIER[32] has made an intimate study of the developing leaves of *Cordaites* from a portion of a silicified bud from the Stephanian of Grand' Croix (Loire). His piece of material was about 3 cm. long and in the matrix immediately around the bud proper and concentric with it had adult leaves identical in structure with *C. lingulatus* of RENAULT. He thinks it reasonable to suppose that these were borne on the same branch which bore the bud itself, especially since he found these leaves identical in structure with the outermost ones of the bud, with the exception of such differences as might be due to age. His conclusion that the bud is that of *C. lingulatus* seems beyond reasonable doubt.

In the young leaves the primordial strands are very small, the bast appearing to develop first as in living forms. In the older leaves the bast is almost always completely destroyed, so that practically nothing was seen of the secondary bast. The protoxylem and centripetal metaxylem develop early, with elements of typical form, ring, spiral, scalariform, and reticulate. The centrifugal wood comes later, appearing first in the region of the protoxylem. About the same time appear certain cells which LIGNIER designates "cellules diaphragmatiques," situated between the bundle sheath and either the body of the centripetal or the sides of the arc of centrifugal xylem. The region occupied by it may be quite extensive. LIGNIER has not compared the bundle with that of cycads, but similar cells do occur in the same region in the cycad bundle, especially lateral to the base of the centripetal xylem.

The sheath consists of several layers of large cells which differentiate early. The cells begin to thicken their walls when the xylem consists of only one or two tracheids. They are most abundant ordinarily at the sides of the bundle, and show certain resemblances to the xylem tissue, to which LIGNIER refers. Most, if not all, of their transverse walls are covered with "punctuations aréolées" and "serées," which are larger, however, and more irregular than those of the tracheary elements. Those on the longitudinal walls are even

[30] Rev. BOT. GAZ. **55**:86. 1913.

[31] KOSSOWICZ, A., und LOEW, W., Vorläufige Mitteilung über das Verhalten von Hefen und Schimmelpilzen zu Natriumthiosulfat. Zeitschr. Gärungsphysiol. **2**:78. 1913.

[32] LIGNIER, O., Différenciation des tissus dans le bourgeon végétatif du *Cordaites lingulatus* B. Ren. Ann. Sci. Nat. Bot. IX. **17**:233–254. 1913.

more irregular. The character of these cells is also very similar to that in the cycads, where the sheath cells right and left of the centripetal xylem are similarly pitted. It is very different from that described by Dr. STOPES for *C. principalis*. She states that the sheath of this form is composed of two parts, an inner of long and slender elements and an outer of short and large ones, both with bordered pits.[33] Recently Miss BENSON[34] has described a form (*C. Felicis*), from the Lower Coal measures of England, with a much less definitely differentiated inner sheath. LIGNIER considers that the "bois diaphragmatique" which he has described corresponds to this "inner sheath" in both these forms. If this conclusion is correct, and there seems little doubt that it is, then his form and that of Miss BENSON have less specialized and more cycadean sheaths than that of *C. principalis*. The bundles of these two forms would thus stand nearer to the *Poroxylon* type, of the detailed structure of which SCOTT in his *Studies in fossil botany* (p. 508) says it is "in fact, that of a cycad." It is interesting to note, in passing, that JEFFREY has chosen the specialized *principalis* type for comparison with *Prepinus* and the Abietineae, while the other is in substantial agreement with the araucarian leaf bundle.

LIGNIER describes at some length the differentiation of certain glandular cells within the bundle sheath. The scelerenchymatous strands above and below the bundle differentiate early, and the mesophyll as well. The cells of the latter have an abundant "protoplasme chlorophyllien probablement accompagné d'hydrates de carbone." The palisade consists ultimately of two or three layers of cells. The epidermis was very poorly preserved and afforded no new data. The bundles were seen to dichotomize, as in ordinary cordaitean leaves, though LIGNIER says that the division does not occur in the same way as STOPES has described in the case of *C. principalis*.

The type of leaf LIGNIER has described is very similar to that of the living broad-leaved forms of the Araucarineae.—R. B. THOMSON.

Water requirement of plants.—BRIGGS and SHANTZ[35] have conducted a series of experiments upon the water requirements of certain crop plants and obtained results which are important not only in determining the most economical plants to cultivate in semi-arid regions, but also in indicating a profitable line of purely ecological research with the natural vegetation of various habitats. The term "water requirement" indicates the ratio of the weight of water absorbed by a plant during its growth to the dry matter produced. The exhaustive review of the literature of the subject will be of great service to all interested in this and allied problems, and demonstrates the fact that while a considerable number of experiments have been performed by a number of

[33] New Phytol. **2**: *pl. 9. fig. 6.* 1903. [34] Ann. Botany **26**: 201–207. 1912.

[35] BRIGGS, L. J., and SHANTZ, H. L., The water requirements of plants. I. Investigations in the great plains in 1910 and 1911. II. A review of the literature. U.S. Dept. Agric., Bur. Plant Ind. Bulls. 284 and 285. pp. 49 and 96. 1913.

workers, the methods employed have as a rule been crude and inexact, leading to much uncertainty in the results. Still it is evident that there was an increase in the water requirement when the soil moisture content approached either extreme; when the soil was deficient in any plant food element; when the amount of soil used in the experiment was small; and when shading of the plants occurred. Atmospheric conditions profoundly affected the water requirement, being greater in dry than in moist air.

The extensive experiments of the present investigators in 1910 and 1911 were conducted at Akron, Colo., with plants grown in water-tight pots containing about 115 kilos of soil each, so sealed that the loss of water was limited to that resulting from the transpiration of the plants, water being added as required. Among other results, it was found that wheat consumed an average of 507 kilos of water for each kilo of dry weight produced, and taking this as the standard (100), the relative water requirements of certain other plants were as follows: alfalfa 211; rye 143; oats 122; barley 106; potato 88; maize 73; sorghum 60; millet 54; and such weeds as *Amaranthus retroflexus* and *Salsola pestifer* 63. These results would indicate the great suitability of sorghum and millet for semi-arid regions. The bulletins contain a mass of detail and much additional data valuable to students of the agriculture and ecology of the great plains.—GEO. D. FULLER.

Agriculture on acid lands.—It has long been known that moors and heaths have acid soil, and many ecological classifications, such as that of WARMING, regard acidity as the chief determining factor of the vegetation. In several interesting and important papers, COVILLE[36] has given the results of some experiments that should almost revolutionize certain phases of agricultural practice. As is well known, various species of *Vaccinium* and *Gaylussacia* are commonly sold in the markets as blueberries and huckleberries, and yet are not cultivated, as are most other commercial fruits. Many attempts have been made to cultivate these berries, and their failure is attributed by COVILLE to the fact that their cultivation has been attempted in rich garden soil. Ordinary cultivated plants, such as alfalfa or roses, grow well in rich garden soil and poorly in peat, unless the acidity of the latter is neutralized by lime. The blueberry, on the other hand, grows poorly in garden soil, thrives in peat, and grows poorly in peat neutralized by lime. After describing the root fungi and their probable rôle in making nitrogen available, the author gives directions for germinating and growing blueberries, showing that fruiting plants can be

[36] COVILLE, F. V., Experiments in blueberry culture. U.S. Bur. Plant Ind. Bull. 193. pp. 100. *pls. 18. figs. 31.* 1910.

———, The formation of leaf mold. Jour. Wash. Acad. Sci. **3**:77–89. 1913.

———, Directions for blueberry culture. U.S. Dept. of Agric. Circular 122. pp. 11. 1913.

———, The agricultural utilization of acid lands by means of acid-tolerant crops. U.S. Dept. of Agric. Bull. 6. pp. 13. 1913.

had in a year or two from seed. It is suggested, however, that cuttings will generally prove more desirable. Of much importance is the fact that in COVILLE'S experiments there were produced berries much beyond the usual size. The experiments were made chiefly on *Vaccinium corymbosum*, but it is believed that other species would show similar behavior.

In one of the later papers, COVILLE describes the changes in the formation of leaf mold, noting its early acidity and its subsequent alkalinity; whereas, peat (not only lowland peat, but also upland peat, as he terms it) retains its acidity, because of the comparative suspension of decay. In another paper, he urges farmers to utilize some of their acid soils by the growth of acid-tolerant plants, and not universally to neutralize them by the use of lime. The work of COVILLE is an excellent illustration of the application of ecological methods to agriculture.—H. C. COWLES.

Sexuality of Mucorales.—In his studies on the sexuality of the Mucorales, BLAKESLEE observed that the sporangium originating from the zygospore of *Phycomyces nitens* contains spores which with respect to sexual differentiation are of three types, giving rise respectively to plus, minus, and neutral mycelia. To account for the occurrence of these three sexually differentiated strains, BURGEFF[37] has formulated a hypothesis according to which the nature of the mycelium is determined by the nuclei which it contains. These may be either (+) or (−), and, since the spores contain one or more nuclei, it is evident that a particular spore may contain either all (+), or all (−), or both (+) and (−) nuclei. In the first two cases, the spores and the mycelium which they produce are said to be "homokaryotic," and in the other case "heterokaryotic." This hypothesis he tested in an ingenious manner. By inserting the tip of a young sporangiophore into the cut basal end of another of the opposite strain, and applying pressure to the wall of the outer one, he was able to rupture the tip of the inner hypha and bring about a mixture of the two masses of protoplasm with their respective (+) and (−) nuclei. Cultures from the sporangia produced by this "mixochimaera" gave (+), (−), and neutral mycelia.

He describes an analogous case of heterokaryosis presented by *Phycomyces nitens* var. *piloboloides*, which differs from the parent in the form of its sporangiophores. The spores of this variety give rise to mycelia which produce either *nitens* sporangiophores only, or *piloboloides* sporangiophores only, or both kinds mixed on the same mycelium. The homokaryotic types remain pure, but the mixed type continues to split in the manner described. Mixochimaeras, formed from the pure selected types, give rise to all three forms. Crosses of *P. nitens* with rigidly selected strains of the variety give rise to all possible forms of both (+) and (−) strains of both types and to heterokaryotic combinations. The production by means of the cross of a (−) strain of var. *piloboloides*, which is (+), is of special interest.—H. HASSELBRING.

[37] BURGEFF, H., Über Sexualität, Variabilität, und Vererbung bei *Phycomyces nitens*. Ber. Deutsch. Bot. Gesells. **30**:679–685. 1913.

Somatic chromosomes in Vicia.—For several years the structure of chromatin has received intensive study at the laboratory in Louvain, and numerous papers have been published by GRÉGOIRE and his pupils. A recent paper by SHARP[38] deals with the somatic chromosomes of *Vicia Faba*. The most important feature of this paper is the investigation of the resting nucleus and very early prophase. Even those investigators who believe in the individuality of the chromosome generally admit that they cannot find the individual chromosome in the resting reticulum, but SHARP claims, apparently with good reason, that the chromosomes in many cases can be identified even in the resting nucleus. Some of the stages leading up to the splitting of the chromosome have been misinterpreted by previous investigators and important stages have been overlooked. The telophasic vacuolization of the chromosome, now found by everyone, often gives the impression of a longitudinal splitting, and such a splitting is frequently described; sometimes the vacuolization results in the formation of short spirals. By schematizing features like these, it is easy to fall into error. Whether the vacuolization has resulted in the simulation of a split thread, or in a spiral, SHARP finds that in prophase a simple zigzag thread is formed which gradually straightens and by axial vacuolization becomes split into the future chromosomes. Thus the actual splitting is later than some have supposed. The vacuolization which appears in telophase has nothing to do with any splitting of chromosomes. There are no chromomeres and no continuous spirems either at prophase or telophase.

The paper is another strong argument in favor of the theory of the individuality of the chromosome.—CHARLES J. CHAMBERLAIN.

Phylogeny of Filicales.—In continuation of his studies of the phylogeny of ferns, BOWER[39] has investigated the monotypic tropical American genus *Metaxya*, which is better known as *Alsophila blechnoides*. Since this fern "has suffered vicissitudes of terminology," having been referred to *Polypodium*, *Aspidium*, *Alsophila*, and *Amphidesmium*, the suggestion was natural that it might be a synthetic type. BOWER concludes that the species deserves to represent a distinct genus, and that it is phyletically in a more primitive position than the true Cyatheae. He has also included with this study a general survey of other relatively primitive and related genera. In connection with this comparative study, BOWER has attempted to estimate the value of various characters for phyletic purposes; and especially "to see whether the position which the sorus holds relative to the margin of the sporophyll is not a more reliable feature, in ferns, at large, than it has commonly been held to be." The conclusion of the whole matter is that, "so far as the value of the general

[38] SHARP, LESTER W., Somatic chromosomes in *Vicia*. La Cellule **29**:297–322. *pls. 1, 2*. 1913.

[39] BOWER, F. O., Studies in the phylogeny of Filicales. III. On *Metaxya* and certain other relatively primitive ferns. Ann. Botany **27**:443–447. *pls. 32–34*. 1913.

phyletic characters of the ferns can be estimated, the criterion of position of the nascent sorus may be held to take precedence, in point of early origin and constancy, over any soral characters except the primal features of the sporangium itself, and over any anatomical characters of the axis derivative from the protostele." This is certainly an important conclusion, and in accordance with it, the leptosporangiate ferns (exclusive of the Osmundaceae) are grouped into two series: the "Superficiales," in which the origin of the sorus is constantly from the leaf-surface; and the "Marginales," in which it is as constantly from the margin.—J. M. C.

Morphology of Riccia.—Miss BLACK[40] in a recent study of *Riccia Frostii* Aust. finds that this species is strictly dioicous and that the sex organs are scattered irregularly in acropetal succession. From the standpoint of the arrangement of sex organs, this indicates that *R. Frostii* is more primitive than *R. natans*, in which the antheridia are clustered in a disk, and the archegonia, which appear later, are usually in two rows. From the standpoint of restriction of antheridia and archegonia to different individuals, an advance beyond *R. natans* is clearly indicated.

Miss BLACK agrees with Miss HIRSH,[41] who also studied *R. Frostii*, that the air chambers are not produced by splitting of cell walls at the angles of the cells, but by papillate outgrowth. Unfortunately, the figure given, as was the case in the work of Miss HIRSH, does not show the earliest stage in the development of the chamber, but can as easily be cited as proof that air chambers arise by splitting at the angles of the cells of the dorsal layer. The youngest air chamber shown is too old to settle the question either way, but a study of the relation of cells in the figure indicates that possibly the chamber may have arisen by splitting of the dorsal layer. This splitting need not originally occur within the tissues as some recent writers assume, but may, as DEUTSCH showed in *Targionia*, extend from the surface inward.

The rest of the investigation, which includes the development of sex organs, spermatogenesis, and sporogenesis, gives us nothing new.—W. J. G. LAND.

Peripheral leaf cells.—In many leafy liverworts there is a marked difference in form and markings of the peripheral cells of the leaf as compared with those farther away from the edge. GARJEANNE,[42] as the result of a study of 10 genera, finds that the thickening of the peripheral cells is stronger if the plant is exposed to conditions which give great variation of water content;

[40] BLACK, CAROLINE A., The morphology of *Riccia Frostii* Aust. Ann. Botany **27**:511–532. *pls. 37, 38.* 1913.

[41] HIRSH, PAULINE E., The development of the air chambers of Ricciaceae. Bull. Torr. Bot. Club **27**:73–77. *figs. 6.* 1910.

[42] GARJEANNE, A. J. M., Die Randzellen einiger Jungermannienblätter. Flora **105**:370–384. 1913.

that the peripheral cells, irrespective of their form and thickenings, show a smaller number of plastids and oil bodies than the other cells of the leaf; that they are frequently distinguished from the flat cells by a greater capacity for taking up aqueous methylene blue and other basic anilin dyes, as well as by a greater blackening with silver nitrate; that the cells which color most strongly are in general those from which regeneration shoots develop and that the greater capacity for taking up color is not due to tannin. He concludes that the peripheral cells contain materials which are of significance for the production of adventitious shoots; that transportation of this material is very possible and consequently any cell of the leaf may thereby become capable of regeneration.—W. J. G. LAND.

The androecium of Parnassia.—Mrs. ARBER[43] has made an anatomical investigation of the stamens of *Parnassia*, and has applied the results to the problem of the affinities of the genus. The vascular strands for the stamens arise at a lower level than those for the staminodia, and the two sets are independent. This seems to confirm the view that the staminodia represent an inner set of stamens. In *P. palustris* the vascular strand traversing the filament is mesarch, "and there are indications of numerous phloem groups arranged round the xylem." This is thought to mean the presence of vestigial vascular strands which indicate that each stamen of *Parnassia* is reduced from an ancestral fascicle of stamens, such as occurs in *Hypericum*. DRUDE'S view that *Parnassia* deserves to represent a family of its own, related to Saxifragaceae, Droseraceae, and Hypericaceae, is confirmed, and the view is expressed that the affinity between *Parnassia* and the Saxifragaceae "has been somewhat overestimated."—J. M. C.

The life history of Thelygonum.—In a study of *Thelygonum* from the germination of the seed to the mature embryo, SCHNEIDER[44] deals with gross morphological features, the development of both staminate and ovulate flowers, the reduction divisions, the development of the gametophytes, fertilization, and the development of the embryo and seed coats. In the cytological portions of the paper, it is seen that the root tips have 20 chromosomes arranged in definite pairs, the reduced number is 10, and fertilization is of the usual double character. In conclusion, the author agrees with HALLIER in placing the Thelygonaceae near the Haloragidaceae. While there is still room for complete life history studies of new or unusual plants, in most cases the time has come for intensive work on special features. In this case it looks as if it might have been worth while to look for a differentiation among chromosomes.—C. J. CHAMBERLAIN.

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[43] ARBER, AGNES, On the structure of the androecium in *Parnassia* and its bearing on the affinities of the genus. Ann. Botany **27**:491–510. *pl. 34.* 1913.

[44] SCHNEIDER, HANS, Morphologische und entwickelungsgeschichtliche Untersuchungen an *Thelygonum Cynocrambe* L. Flora **106**:1–41. *figs. 23.* 1913.

Apical cells of Marsiliaceae.—"Contributions to the developmental history of the Marsiliaceae" is the rather broad title of a paper by SCHNEIDER,[45] dealing with the apical cell and its segmentation in the vegetative organs of this family. The first part deals with the main axis and the second part with the lateral organs derived from it, the leaf, branch, and root. The apical cell of the axis is so oriented that two segments are dorsal and one is ventral. Roots are derived from the ventral segments, while leaves and branches come from the dorsal. In the behavior of the apical cells and their segments *Marsilia* and *Pilularia* differ from each other only in minor particulars. The work, which seems to be quite accurate, confirms and extends somewhat the earlier work of JOHNSON.—CHARLES J. CHAMBERLAIN.

Anatomy of Salicornia.—Miss DEFRAINE[46] has investigated the anatomy of *Salicornia*, and among the results the following are noted. The succulent "cortex" covering the internodes is phylogenetically derived from the basally developed leaf-sheath of the pair of leaves of the node above. The evidence for this seems quite convincing. The small, fleshy cotyledons fuse to form a cotyledonary sheath to the hypocotyl, similar to the leaf-sheath of the vegetative shoot. The occurrence of every transition between spiral cells and stereids led to the conclusion that the two are homologous structures, the former functioning chiefly in water storage, the latter in mechanical support. A peculiar kind of secondary growth sets in early in both root and stem.—J. M. C.

Endogenous gemmae.—The formation of endogenous gemmae is reported in *Haplozia caespiticia* by BUCH.[47] From within a gemma mother cell, numbers of which develop on the swollen end of a stem, two to four gemmae are produced and set free by the bursting of the wall of the mother cell. Mucilage within the mother cell absorbs water, swells, and bursts the wall. Endogenous gemmae have heretofore been reported for two genera, first in *Aneura* by GOEBEL and later in *Metzgeria* by EVANS.—W. J. G. LAND.

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[45] SCHNEIDER, FRITZ, Beiträge zur Entwickelungsgeschichte der Marsiliaceen. Flora **105**:347–369. *figs. 18.* 1913.

[46] DEFRAINE, ETHEL, The anatomy of the genus *Salicornia*. Jour. Linn. Soc. Bot. **41**:317–348. *pls. 15, 16.* 1913.

[47] BUCH, HANS, Über die Brutorgane der Lebermoose. 8vo. pp. ix+70. *pls. 3.* Helsingfors: J. Simelii Arvengars Boktryckeriaktiebolag. 1911.

GENERAL INDEX

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